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BRITISH EXHIBITS.

A CORRESPONDENT of the *Engineer* writes home as follows about some of the British exhibits:

JACQUARD LOOM.

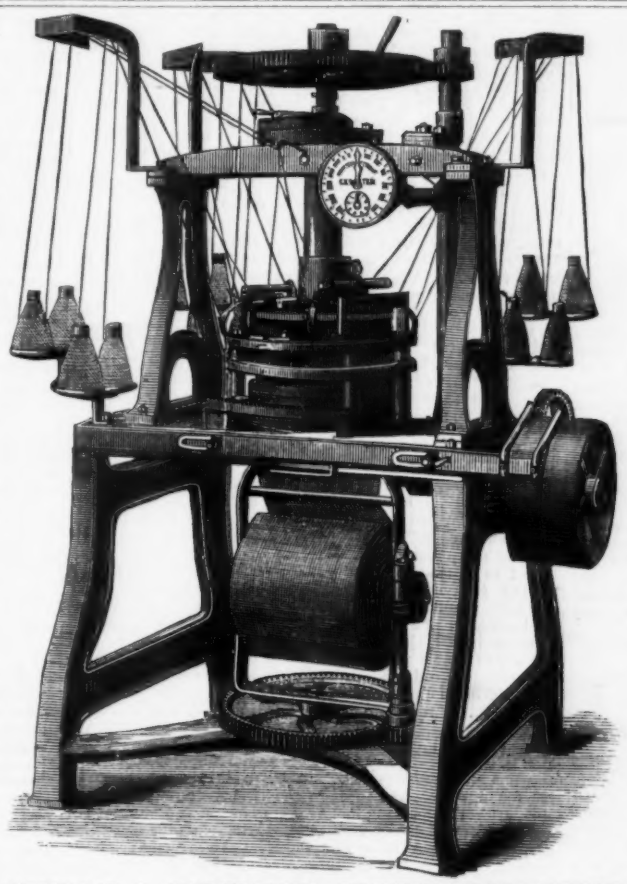
Mr. Thomas Stevens, of Coventry and London, contributes a very fine specimen of the Jacquard loom. It is furnished with eight colors, and yet is very easily worked. It is provided with a separate motion for the cylinder, by which means the durability of the card is considerably increased, owing to the diminished friction upon its surface. Mr. Stevens' loom is engaged in the production of very artistic silk-woven book-markers, with admirably executed portraits of Washington and a view of the Horticultural Hall, with appropriate Centennial sentiments and emblems woven between them.

MACHINE FOR KNITTING CARDIGAN JACKETS.

In the immediate vicinity of this loom is situated Messrs. Gimson & Coltman's patent knitting machinery. The Cardigan jacket machine will make either the polka stitch or the one-and-one stitch, and is fitted with a suitable action for making a welt at any desired time, according to the length of jacket required. As one of the first things that strikes a stranger in this country is the universal use of Cardigan jackets by the laboring classes, Messrs. Gimson & Coltman have exercised good judgment in forwarding one of these machines for exhibition, as they produce a very superior article. Another of their machines is for making the sleeves for the Cardigan jackets, on the same principle as the last-mentioned machine. A somewhat delicate-looking and complicated apparatus is for producing half hose; it makes rib tops with welts and slack-course, and has a patent wheel which can be altered to make any desired pattern; the length of top can also be varied, and the self-acting winding tackle for receiving the work only requires a few minutes to remove the fabric and proceed with further production. A dial indicates the amount of work executed.

CLOTH-CUTTING MACHINE.

A decided novelty is Sanson's spring-arm endless band knife cloth-cutting machine shown on the following page. This machine is used for cutting out large numbers of uniforms or other articles of apparel of identical forms, and will cut through layers of cloth from 2 inches to 4 inches thick, according to the nature of the material, and if driven by steam-power will cut out about 1500 cloth garments per day. The principal features of this machine are the springs in the upper arm by which the hard running of the band knife is avoided and the large size of the gap, thus rendering it unnecessary to fold the cloth as it is mined to meet the edge of the knife, an operation difficult to perform when a considerable thickness of cloth is being cut, and if attempted the folding interferes with the accuracy of the shape of each piece. The cleanness of the edges of the cloth cut with this instrument is remarkable, and provision is made for sharpening the knife when in motion by the application of an emery wheel. Mr. Sanson also exhibits a parallel lifting pressing machine, in which the iron can be readily moved in any direction, and by means of the parallel foot-treadle with a counter-balance the pressure can be uniformly distributed over the whole surface of the board; the iron is heated by gas from a flexible tube fitted with an improved burner.



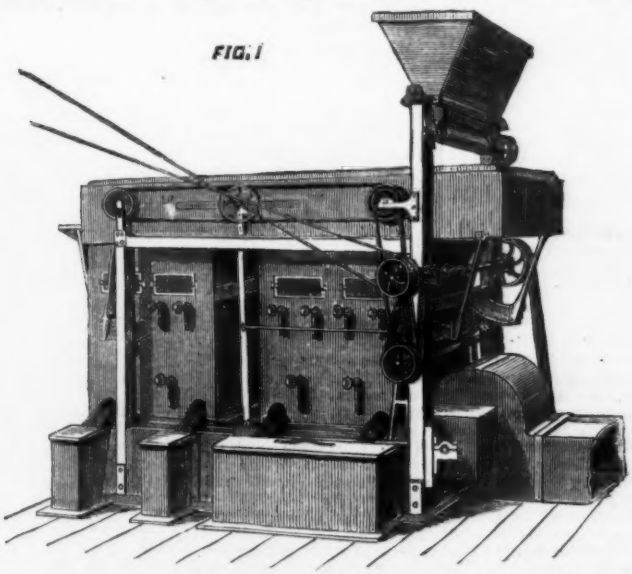
GIMSON & COLTMAN'S KNITTING-MACHINE.

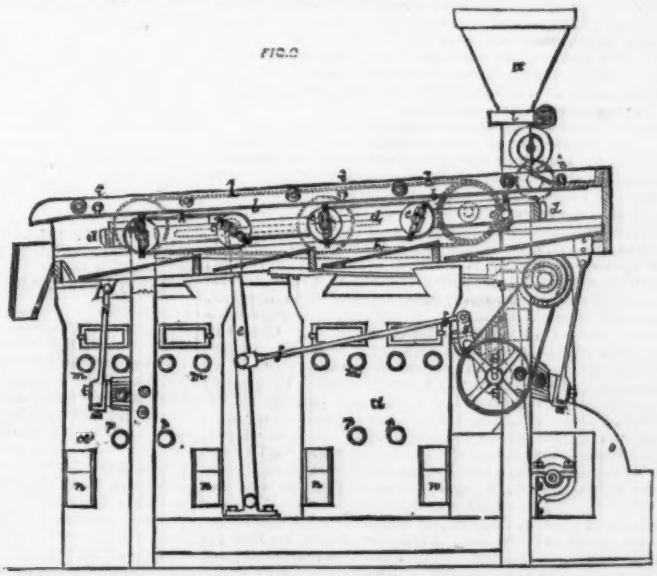
MIDDLINGS PURIFIER.

Sutcliffe's patent "Paragon" middlings purifier will be interesting to the millers who may see it. Middlings represent the kernel of the wheat, and this apparatus cleans the kernels from the husks after the first crushing and divides the kernels into different sizes. The annexed drawing is a side elevation drawn partly in section. *a a a a* are the ordinary parts of the machine, and *b b* the silk sieves; *c c c c* are revolving brushes, mounted beneath the sieve in a frame or carriage *d d*, to which a slow reciprocating motion is given by means of the arm *e e*, link *f f*, and crank *g*, or by a worm as hereafter described. The brushes *c c* are at the same time caused to revolve rapidly by means of endless cords or bands *h h* passing round pulleys keyed on the axis of the brushes. The traverse to and fro of the brushes is about equal to the distance between the brushes, or rather more, and thus, as the brushes reciprocate slowly and at the same time revolve rapidly, every portion of the under side of the silk is kept constantly brushed, and choking or clogging of the sieve is entirely prevented, the sieve *b b* having at the same time a short and rapid reciprocating motion given to it as usual, and by the ordinary means. Although constantly acted upon by the revolving brushes, the silk sieve does not wear out as might be expected; and in order to allow of the sieve being raised or lowered as required, the holes at *i i*, through which pass the bolts for fixing the sieve to the side of the frame, are slotted or elongated in a vertical direction. On Fig. 3 a right and left-hand threaded screw *k k* or worm is shown, as applied to the machine, to give the slow reciprocating motion to the frame or carriage *d d*, in which the revolving brushes are mounted. The silk sieve is fine at the end nearest the hopper and grows gradually coarser, and by this means, with the assistance of the regulating boards *m m*, different finenesses can be drawn from the spouts *n n*, at the option of the miller.

Messrs. J. & H. Gwynne have confined themselves to sending a model instead of some actual specimen of their well-known centrifugal pumping machinery, but the model is beautifully executed, and faithfully represents one pair of compound surface condensing engines with patent centrifugal pumps, made to ½ in. scale; the original engines are one pair of four similar sets erected at Codigoro, near Ferrara, in Italy, capable of raising 2000 tons of water per minute, which have been already described in *The Engineer*. In the immediate vicinity are model and drawings of Clarke & Stansfield's patent lifting dock.

Messrs. Lawson & Sons, of the Hope Works, Leeds, show a very complete collection of jute spinning machinery, consisting of a breaker carding engine, finishing carding engine, patent first drawing machine, second drawing machine, roving frame, spinning frame, and a cop machine. There is no striking novelty about any of this machinery, but it is shown merely as a specimen of good useful working articles, of superior quality, and which is largely imported into America; and I am glad to find that in this class of machinery our English manufacturers can successfully compete with their American brethren both as to quality and price, in spite of the objectionable tariff; but the Americans will derive some satisfaction from noticing that the first drawing frame is fitted with a chain gill, invented by Mr. John Good, of Brooklyn. This machinery was one of the first to be in working order in the Exhibition, being ready to start several days before the opening. The counter shafting is connected with the several machines in the usual way by belting, but is driven from the main shafting by means of ropes, which are preferred by Messrs. Lawson & Sons for this purpose, as they consider that the ropes impart a steadier motion than belting; but if so, why do they not adhere to the same principle throughout, and connect the machines to the pulleys on the countershafts by means of ropes?

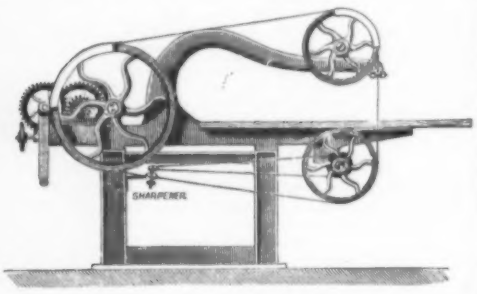




THE INTERNATIONAL EXHIBITION OF 1876.—THE PARAGON MIDDLINGS PURIFIER.

Another very complete set of jute spinning machinery is exhibited by Messrs. Fairbairn, Kennedy & Naylor, also of Leeds. Unfortunately this firm did not obtain sufficient space to enable them to show the first machine used in their process—namely, the breaker card; but the exhibit commences with the finishing card. The next in order is one of their patent link gill drawing frames, for which they claim the advantages of being able to work at a high rate of speed, and that by the peculiar action of their patent links the gills work close to the

rollers. An ordinary spiral gill drawing frame shows the difference between the spiral system and their patent link; and although the former turns out better work, it can not be driven at so high a speed as the latter. A roving frame with improved spiral heads to the spindles, by which the flyers are prevented from jumping up, is a great improvement on the ordinary method of construction. A separate motion is provided for every head, so that in case one portion of the machine becomes clogged, only one head will stop, and the entire machine does not break down, as too frequently occurs when all the heads are driven by one motion. The spinning frame is fitted with a traversing motion to prevent the rove from wearing a groove in the retaining roller, as is the case when it always runs in the same position; the drawing rollers can also be adjusted to traverse the face of the wood pressings for the same purpose; the wood pressings are held up to their work by a patent spring pressing apparatus, in lieu of weights, to enable the pressure to be easily regulated. The spindle steps are fitted with solid brass screw covers to keep out the dust



CLOTH CUTTER AT THE EXHIBITION.

and prevent waste of oil; this is an expensive fitting, but a very desirable one, considering the high rate of speed at which these spindles are run. Messrs. Fairbairn, Kennedy & Naylor's machines are driven from the main shafting, and owing to some misunderstanding as to the position of the shafting, some rather long belts and awkward guide-pulleys have been employed. The machines are all of first rate quality, plainly got up as merchantable articles, and without an exhibition polish about them. Messrs. Fairbairn, Kennedy & Naylor are also the exhibitors of a novel and useful machine tool for shops where large numbers of similar articles have to be turned out, such as axle-boxes, buffer-boxes, or Mansel wheel-boss, which I hope you will be able to illustrate in an early number. It consists of a quadruple boring and drilling machine with four fixed arms holding spindles 3½ in. in diameter, driven off one set of gearing, and provided with rising and falling traversing tables. This is a good tool, and one likely to be extensively adopted in railway carriage shops.

THE INTERNATIONAL EXHIBITION OF 1876.

No. 15.

IRON SHIPBUILDING AND MARINE-ENGINE CONSTRUCTION. EXHIBIT OF MESSRS. JOHN ROACH & SONS.

IN the Transept of Machinery Hall, near the north end, may be found an exhibit by the above-mentioned firm, which, perhaps, more than any other one in the building, or under the Machinery Bureau, represents the progress made in this country during the last fifty years in those important branches of human industry involved in the construction of the iron steamship and marine steam-engine. There is probably no individual structure erected by the hands and brains of men which involves higher engineering problems, or which includes within itself more completely all that engineering consists of, than the modern iron screw-steamer. To successfully produce a vessel in which strength, safety, speed, economy, comfort, and convenience of passengers and crew, carrying capacity, and, if it be a war vessel, offensive and defensive power, facility of movement, and the many other minor necessities of such a vessel, is a problem second to none which is presented to the scientific engineer and mechanician. The man, therefore, who, with all the scientific attainments possible to reach in our best schools, colleges, and industrial establishments, can produce successfully an iron screw-steamer, such, for example, as some of the later additions to the Pacific Mail S. S. Co., is justly entitled to a place in the front rank, among the benefactors of the race. There is a still higher meed of praise, however, due to the man who is at the head of this concern, from the fact that, without any of the advantages so easily obtained in these days for the young student of science, and working himself up, unaided, from the very lowest round of the social and scientific ladder, he is capable of to-day presenting the world with a steam vessel for the purposes either of peace or war, which is fully up to the highest standard of the day, either in this or the older countries.

Born in Ireland, John Roach began his career in this country as a common laborer in an iron foundry in New-York, whence he gradually raised himself through the several gradations of the artisan, until, becoming skilled in his craft, he managed to establish himself in business in an unpretending little foundry in Goerck street, New-York. Once embarked as his own master, he is soon found to be the proprietor of the Etna Works, an extensive establishment in its day, in which was produced the magnificent iron bridge over the Harlem River, and several of the largest engines for the merchant, marine, and U. S. Navy. This place, however, soon became too circumscribed for this indefatigable mechanic, and he becomes the owner of the extensive and well-known establishments, the Secor Iron Works, the Morgan Iron Works, and the Allaire Works, all in New-York. Then he purchases the comparatively insignificant establishment of Reaney & Archibald, at Chester, Pa., and, to supplement his now extensive machine works consolidated from the above, he lays the foundation of his present splendidly appointed ship-yard; and besides these he is the owner of a large rolling-mill at the same place, and is largely interested in sundry blast furnaces and iron and coal mines in Pennsylvania; until now in his own industrial works in New-York and Chester he employs about 2600 men; and, as his exhibit shows, he is capable of vieing with the most extensive and oldest concerns in the Old World in all that pertains to marine engineering. This is a record of which the poor foundry laborer may well be proud.

This exhibit includes a number of fine models of vessels, as well as specimens of the various special works belonging to them in their progressive stages. There is shown a beautiful working model of the American beam river-boat engine, plated in gold and silver, which cost $2700. It is arranged so as to be kept in motion by means of clock-work within the case upon which it stands. This piece of work is very much admired. A far more interesting model, however, at least to mechanics, is that of the engines of the sound steamers "Bristol" and "Providence;" which is a complete and perfect working copy of the "Bristol's" engine, even to the minutest detail. This engine is remarkable as having the largest steam cylinder ever cast, even up to the present time; that is to say, having the largest volume. It is 110 ins. diam. by 14 feet stroke. It also has the largest and heaviest skeleton or truss-beam ever made, which weighs 24 tons. The engine is 45 feet high from keelson to beam-centre, and the paddle wheels are 42 feet in diameter. This model includes a cross section of that part of the ship inclosing the engines, and is made of the precise materials and is a perfect miniature copy of the original machine. It cost over $5000. There is also a working model of a steam yacht complete in all its parts, which has made four miles per hour in the water, although but 5 feet long. Then there is a model complete on a scale of ¾ inches = 1 foot, of the double-turreted monitor, "The New Puritan," now in process of reconstruction at the works in Chester. The side armor on this vessel is 12 inches thick, and weighs 2000 tons. The turrets are 15 inches thick, and weigh each, exclusive of guns, 375 tons. The hull of the ship is nearly all renewed, and is one of the first ships ever built in this country on the cellular principle. She is of 5500 tons measurement, and displaces 7500 tons of water. The armament will consist of two 20-inch smooth-bore guns and two 12 inch rifles. A large piece of the deck of this model is made detachable, so as to expose to view the boilers, machinery, etc., which are all complete in every part. The model is 9½ ft. long, 22 in. beam, and 7½ in. deep, and has twin screws, with two pairs of engines.

There are shown a large number of builders' models of ships, which have been built either wholly or in part by this firm, among which may be mentioned the "Geo. W. Elder," an iron screw-vessel, which has the unprecedented record of having been run for one year upon an average consumption of 1.86 lbs. of coal per H. P. per hour; the "Colon," which has been still more economical on a round trip between Aspinwall and New-York. There are also models of the monitor "Miantonomoh," now rebuilding at Chester; the "City of Peking," "City of Tokio," "City of San Francisco," and two ships, sister to the latter, all of the Pacific Mail Steamship Company. To these may be added a great many elegant engravings and paintings of vessels produced by this concern, altogether making up a very complete record of the productions of John Roach & Sons.

They exhibit a plate of fagoted iron, a part of the "Puritan's" side armor, finished on the planer, the better to exhibit its quality, which measures 10 ft. by 3 ft. 8 in., is 12¾ in. thick, and weighs 10 tons. The establishment is capable of producing a plate of the same superficial dimensions up to 3 feet in thickness: it is to be tested by solid shot from a 20-inch gun, under the auspices of the Government. This plate, be it remembered, is not rolled, but built up of fagoted scrap, under the steam-hammer of the works, having a ram weighing 7½ tons.

They exhibit a very fine specimen of boiler flanging for a super-heater head, made from a circular plate of best charcoal iron, 106 in. in diameter and ⅝ in. thick. The edge is flanged down 5 in. all round for connection to shell, and there are four flue openings in it 30 in. in diameter, flanged out from holes of 7 in., and the flanges are 6 in. deep, without reduction in thickness in any part. As a remarkable feat in flange forging, the operator, a Mr. Ambler, well known in this connection, cut the plate through the centre, or on a diameter line, after the flanging had been completed, and rewelded it without distortion or perceptible reduction in thickness; and so well is the work done that the weld can scarcely be traced upon it. The plate is the largest of circular form ever made in this country.

They also show a wrought-iron crank shaft for the side-wheel steamer "Massachusetts." It is finished all over, and weighs 5 tons. In connection with this is a crank shaft for the same vessel, which is among the largest ever made. It is 36 ft. long, 22 in. in diameter, weighs 26 tons, and is without a visible flaw upon its surface. The steam-cylinder of this ship is 90 in. diameter and 14 ft. stroke.

There is also a boiler plate ⅝ in. thick, and 25 ft. by 8 ft. 6 in. surface, which is the largest boiler plate ever made in this, and the widest ever made in any, country: it weighs 4563 lbs.

In addition to these are a number of very fine specimens of the well-known American "Sligo" iron, which brand is largely consumed by this firm. Several pieces are shown which have withstood the tensile test of 30 tons to the square inch, and one piece of 1½ round bar lifted 37 tons from the ground in the effort to tie it cold into a knot. There are also some of the best specimens of fibrous texture in fractured wrought-iron the writer has ever seen, and many interesting items, illustrating at once the character of the materials used and the power of the tools with which they are produced or manipulated, among which are a lot of chips, taken from the crank of the "Massachusetts" by the slotting machine, 3½ in. wide and over ½ in. thick.

No one interested in such matters can spend a couple of hours more profitably or agreeably than in an inspection and examination of the evidences of enterprise and progress presented by this self-made engineer and mechanic.

J. T. H.

ELECTRO-MAGNETISM.

IT appears from the *Bulletino Telegrafico*, of Florence, that Mr. Joseph B. Stearns, in a letter to the Commander D'Amico, Director General of Italian Telegraphs, informs him that he has found that to Italy is due the discovery of electro-magnetism, as well as the honor of having made the first Voltaic battery. The facts on which this is based are mentioned in Mr. Sabine's *History and Progress of the Electric Telegraph*. It appears that the effect of a current acting on a magnetic needle is mentioned by Professor Izaru in his *Manuel du Galvanisme* (published at Paris in 1804), as observed by Romagnosi, a physicist of Trent, that I. Mojon, a learned chemist of Genoa, stated that non-magnetized needles obtained "a kind of polarity" when submitted to the action of a current. The *Bulletino Telegrafico*, in mentioning this, observes that they thank Mr. Stearns, as they truly believe that the observations of Mojon are little known. Not so in the case of the illustrious Romagnosi, who was not from Trent, but from Salsomaggiore, near Piacenza. It was true it was at Trent that he made his discovery of the deviation of the needle by the electric current. The fact is fully recorded in an epitaph by Pietro Giordani, at the College Alberoni, near Piacenza. It states that the deviation of a magnetic needle by a galvanic current was noticed and published by him in 1802. In the book in question the name is spelt Romagnesi, whereas it should be Romagnosi.

TO CALCULATE THE GEAR-WHEELS NECESSARY TO CUT A THREAD IN A SCREW-CUTTING LATHE.

By JOSHUA ROSE.

THE pitch of a thread is the distance or width from one thread to the next one, and is usually measured by the number of threads contained in an inch of length; the pitch is, therefore, spoken of as so many threads to the inch. In measuring the pitch of a thread, the rule or scale is applied to the top of the thread, but it must be borne in mind not to count the thread at the beginning of the inch, since the pitch is the number of spaces and portions of a space between the threads contained in the inch.

What is called (as applied to its screw-cutting wheels) a single-geared lathe, is one in which the driving gear is either fastened upon and revolves with the mandril of the lathe, or else is driven by an intermediate gear-wheel, of such a size that the driving gear, though not fast upon the lathe spindle or mandril, still makes the same number of revolutions per minute as does that mandril, while at the same time no two wheels (on a single-geared lathe) run side by side making an equal number of revolutions in a given time.

In such a lathe we have only to consider the driving wheel or gear, and the gear upon the feed screw of the lathe, the others or intermediate wheels having no effect or influence upon the thread to be cut, and only serving to make up the distance between the driving and feed-screw gears, and to communicate the motion of the one to the other, so that having ascertained what sized wheels are required for the driving wheel and on the feed screw, we may connect them together by any wheel or wheels that will answer, irrespective of their sizes.

It will be readily perceived, then, that if the driving gear and the feed-screw gear contain respectively the same number of teeth, the lathe would be geared to cut a thread of the same pitch as the pitch of the thread on the feed screw of the lathe, because the feed screw would revolve at the same speed as the lathe did. It follows, then, that in exact proportion as the feed screw revolves slower than does the lathe spindle or mandril, will the thread cut by the lathe tool be finer in pitch than that on the feed screw, and *vice versa*. Hence we have as a rule whereby to find the wheels necessary to cut a thread of a required pitch in a single-geared lathe.

Divide the pitch of the thread you want to cut by the pitch of the thread upon the feed screw of the lathe, and use the product as a divisor to the number of teeth contained in the wheel upon the feed screw, and the last product will be the number of teeth required in the driving wheel.

Example: It is required to cut a thread of a pitch of eight threads to an inch, using a lathe whose feed screw has a pitch of four threads to the inch, the wheel upon the feed screw containing

$$\underset{\text{required.}}{\text{Pitch}} \quad 8 \quad \div \quad \underset{\text{feed screw.}}{\text{Pitch of}} \quad 4 \quad = 2$$

$$\underset{\text{gear.}}{\text{Teeth in}} \quad 80 \quad \div \quad 2 \quad = 40$$

= the number of teeth required on the driving wheel.

The usefulness of this rule lies in the fact that the driving wheel used in lathes having no independent feed motion is generally one of the smallest ones, so that it is almost always necessary to remove the driving wheel (because the feed of the lathe is usually finer than the pitches of the ordinary threads in use); and we may, therefore, place our largest gear upon the feed screw, and shall rarely require to remove it, unless the thread required to be cut is coarser than is the pitch of the feed screw of the lathe. If this latter is the case we adopt the following rule: Divide the pitch of the thread required to be cut by the pitch of the thread on the feed screw, and multiply the product by the number of teeth contained in the driving gear; the last product will be the number of teeth required for the gear upon the feed screw.

If there is no wheel either upon the feed screw or the driving spindle, we may employ the following rule: Divide the pitch of the thread you wish to cut by the pitch of the thread on the feed screw, and the quotient will be the proportion which must exist between the number of teeth on the driving gear and the feed-screw gear.

Example: The feed screw of a lathe has a pitch of four threads to an inch, and it is required to cut a thread having a pitch of eight threads to an inch: what must be the number of teeth upon the driving gear and the feed-screw gear respectively:

$$\underset{\text{to be cut.}}{\text{Pitch of thread}} \quad 8 \quad \div \quad \underset{\text{feed screw.}}{\text{Pitch of}} \quad 4 = 2 = \left\{ \begin{array}{l} \text{Proportion between the} \\ \text{required gears.} \end{array} \right.$$

That is to say, the proportion between the gears must be two to one, or in other words, one wheel must contain twice as many teeth as the other. We may, therefore, pick out from our gear-wheels any two wheels in which one contains twice as many teeth as the other, and say "since the thread to be cut is finer in pitch than the thread upon the feed screw, it is evident that the feed screw must revolve slower than does the lathe spindle or driving gear; hence the largest of our two selected wheels must be placed upon the feed screw, and the other must be placed upon the driving spindle or lathe mandril."

The term *compound* or double-geared lathe as applied to the screw-cutting gear of a lathe means that there exists, between the gear wheel which is fastened to and revolves with the lathe spindle and the feed screw, two gear wheels of different diameters—that is, containing a different number of teeth and revolving side by side at the same number of revolutions, by reason of being fixed upon the same sleeve or axis. The object of this arrangement is to make between the speed at which the lathe spindle or mandril will run and the speed or revolutions at which the feed screw will run, a greater amount of difference than is possible in a single-geared lathe, and thus to be able to cut either coarser or finer threads than is practicable in a single-geared lathe. This is usually accomplished by providing two intermediate wheels of different diameters, both being held by a feather to a sleeve revolving upon an adjustable pin provided for the purpose. It is obvious that the smallest of these compounded or coupled gear-wheels will usually be required to gear into and with the wheel or gear upon the feed screw; and that the changes of gear may be made upon the gear running on the lathe mandril and that running on the feed screw without disturbing, except in unusual cases, the pair of intermediate (and compounded) gears. In many cases, however, only the wheel upon the feed screw need be changed, since a wide range of pitch may be obtained by changing that wheel only. To find the number of teeth in the wheel required to be placed upon the feed screw, we have the following rule:

Divide the pitch of thread to be cut by the pitch of the thread on the feed screw of the lathe, and the product will be the proportional number. Then multiply the number of teeth on the lathe mandril gear by the number of teeth on the smallest gear of the compounded pair and the product by the proportional number, and divide the last product by the number of teeth in the largest wheel of the compounded pair, and the product is the number of teeth for the wheel on the feed screw of the lathe.

Suppose, for example, the gear on the lathe mandril contains 40 teeth running into the largest of the compounded pair of gears, which contains 50 teeth, and that the small gear of the compounded pair contains 15 teeth, what wheel will be required for the feed screw—its pitch being 2, and the thread required to be cut being 20?

Pitch required.		Pitch of feed screw.		Proportional number.
20	÷	2	=	10

Then

Mandril gear teeth.		Small compound gear.		Proportional number.		Large compound gear.		
40	×	15	×	10	÷	50	=	120

= the number of teeth required upon the wheel for the feed screw. In the above rule and example, however, all the necessary wheels except one are given; and since it is often requisite to find the necessary sizes of two of the wheels, the following rule may be used:

Divide the number of threads you wish to cut by the pitch of the feed screw, and multiply the quotient by the number of teeth on one of the driving wheels, and the product by the number of the teeth on the other of the driving wheels; then any divisor that leaves no remainder to the last product is the number of teeth for one of the wheels driven, and the quotient is the number of teeth for the other wheel driven.

[It may be as well here to explain, that the term "wheel driven" means a wheel which has motion imparted to it by another wheel, while its teeth do not drive or revolve any other wheel. And also that a driving wheel is one whose duty is to impart motion to another wheel; hence the wheel on the lathe spindle is a driving wheel, and the one it drives is a wheel driven, while the wheel on the feed screw is a wheel driven, and the wheel which drives it is a driving wheel or gear, as it is more commonly termed.]

Example: It is required to cut a screw whose pitch is 20 threads to the inch, the pitch of the feed screw being 2; one of the driving wheels contains 40 teeth and the other contains 15:

Pitch required to be cut.		Pitch of feed screw.		Teeth in one driving wheel.		Teeth in other driving wheel.	
20	÷	2	×	40	×	15	= 6000.

Then, 6000 ÷ 50 = 120; hence one of the driven gears will require to contain 50 and the other 120 teeth. If, however, we have not two of such wheels, we may divide by any other number instead of fifty. Thus 6000 ÷ 60 = 100, and the wheels will require to have respectively 60 and 100 teeth.

If there are no wheels upon the lathe, we may use the following rule:

Divide the pitch required by the pitch of the feed screw, and the quotient will be the proportion required between the speed of the first driving wheel and the gear on the feed screw; then, any two numbers that will, multiplied together, make a sum equal to the required proportion, will be the proportion for each pair of gears.

Example: It is required to cut a thread of 20 to the inch, the pitch of the feed screw being 4.

20 ÷ 4 = 5 = the proportion between the speed of the first driving wheel and the feed screw; and the thread required being of finer pitch than that of the feed screw, it is obvious that the latter requires to revolve only one fifth as fast as does the first driving wheel.

We now consider what two numbers multiplied together will make 5. Well, 2½ × 2 = 5, and hence we may gear one pair of wheels 2½ to 1, and the other pair 2 to 1, irrespective o the number of teeth they contain, so that the proportion is maintained; and since the thread required is of finer pitch than is the feed screw, it is obvious that the small wheels must be used as drivers. We may therefore use as a first driver a 10 driving a 25—that is, 2½ to 1; and for the second pair we may employ a 20 as a driver, and a 40 on the feed screw—that is, 2 to 1.

SHIPS OF WAR.

By N. BARNABY. A paper recently read before the Institution of Naval Architects.

THE circumstances and conditions of naval warfare stand at present as follows: (1) Looking at the relative distances within which the gun, the torpedo, and the ram are operative, and the risks of failure in striking with them, the gun occupies the first place and the ram the last as instruments of naval warfare. (2) From this it follows that ships built only for ramming, forego the use of two more important weapons. That a ship built wholly for torpedo service is better than a ram, but is still inferior to one built for service with guns only. The advantages of combinations of these weapons follow the same rule. (3) That while the gun is, on the whole, the superior weapon, it can be resisted more easily than either of the others. If it were as difficult to resist the effects of the blow of the gun as it is the blow of the torpedo or the ram, naval warfare would cease to be practicable. (4) The growth of resistance to the gun encourages further increase in the power of the gun, and there appears at first sight to be no limit to this increase. The limit will probably be found in the cost of putting the gun afloat with proper protection for it, and proper speed. (5) The torpedo can be made, within the proper range of its operations, irresistible. Before proceeding further upon this matter, I think it to be desirable to refer to what has already been done in ships of war for the purpose of resisting rams and torpedoes. There have been four important cases of ramming between English ironclads, namely, the *Hercules* ramming the *Northumberland;* the *Minotaur* bow on to the *Bellerophon;* the *Resistance* bow on to the *Devastation;* and the *Iron Duke* on to the *Vanguard.* In all cases the blow was unexpected, and the ship was unprepared. In three out of the four cases the provision made against an accidental blow of the ram was effective. In the first the outer bottom was torn open, and the wing compartment filled, but no further harm was done. In the second the armor and frames were driven in bodily four or five inches, but the leakage was confined to the wing department. In the third, the armor was not much displaced, and there was no leakage. In the last, the ship was struck with a force as great as is ever likely to be attainable in an action, and in the most fatal place. She was unprepared to receive it, but she, nevertheless, floated more than an hour, and only took in water at the rate of from 15 tons per minute at the commencement, to 27 tons per minute just before she sank. From this we may conclude that the gross area of the openings in the inner bottom could not have exceeded a square foot. If these results are compared with the results of collisions in ordinary ships, it will be admitted, I think, that much has been done in ships of war in the way of protection against the ram. Moreover, the *Vanguard* was greatly inferior in the matter of bulkhead divisions to the ships now in course of construction, such as the *Dreadnought*, the *Alexandra*, the *Temeraire*, the *Nelson*, *Northampton*, and the *Inflexible*, as any one may see who will take the trouble to inspect those ships. In the matter of defence against torpedoes, the experiments against the bottom of the *Oberon* showed a far higher resisting power than the double-bottom system had been credited with; and as to one of our most recent ships, the *Inflexible*, I give a sketch showing what would happen under the action of Whitehead torpedoes. Notwithstanding this, I say it is idle to attempt to form the bottom of a ship strong enough to resist a fair blow from a powerful torpedo. The utmost that can be done is to keep the disabled ship afloat after she has received such a blow. It would be possible to protect the bottoms of ships with armor to withstand the present charges of the Whitehead and Harvey torpedoes, but this must be done either by giving up some of the defence against the ram in speed, or of the defence against the gun in armor, or by building larger and more costly ships. When this was done, it would only be necessary to increase the charges of the torpedoes, and the armor we had applied would become vulnerable. (6) If the blows of the torpedo are to remain irresistible when fairly delivered, it remains to be considered in what manner and to what extent the attack can be met, because it would appear that it only needs high speed and armor defence in the torpedo ship, to give her control over the situation, and enable her to come down upon her adversary in the open day and deliver her fatal blows; and, under cover of darkness, she would not even need armor. The attack, moreover, of several fast unarmored rams or torpedo ships upon a somewhat slower armored ship, although involving the probable destruction of some of the attacking vessels, would still expose the armored ship to fatal blows. (7) The possibility of such attacks by armored rams or torpedo ships, or by numerous unarmored vessels of this kind, exposes the costly armor-clad ships to a risk which they ought never to encounter alone. The assailants ought to be brought to bay before they could get within striking distance of the ironclad by consorts armed like the attacking vessels, with the ram and the torpedo, which may take, like them, the chances of being sunk. In other words, I contend that the defence against the ram and the torpedo must be sought for not in the construction of the ship alone or mainly, but also and chiefly in the proper grouping of the forces at the points of attack. (8) If the foregoing considerations are correct, there is still place in naval warfare for costly ironclads with thick armor and powerful guns. There is place also for association with them of unarmored vessels, armed with the torpedo and manned by brave men. (9) There is work also for lightly armored and partially-armored ships, because any armor obliges the adversary to increase the power and diminish the number of his guns. A thinly armored ship will receive fewer effective hits than an unarmored ship, and of the hits which are effective, only a small proportion will have any chance of bursting within the ship, because thin armor explodes most shells in the act of perforation, whereas with no armor the explosion would take place after perforation. (10) Under the name of armored ships I include all ships in which the means of propulsion and of offence are protected against artillery by iron plating, whether that plating be vertical or horizontal. Horizontal armor is displacing or supplementing, and is likely to displace or to supplement still more in the future, vertical armor. (11) The introduction of armor-plating has tended to the advantage of England, as compared with her rivals, because it has admitted of the use of iron instead of wood in the construction of ships of war, and it is now established that it not only admits of the use of iron, but it absolutely excludes the use of wood, except for secondary purposes. (12) The torpedo has served, and will serve, England also, by giving us the means of defending our coasts and harbors effectively, and the invention of the Whitehead and Harvey torpedoes in particular, has placed in the control of our grand fleets of unarmored merchant ships a weapon with which the most powerful ships of war may be disabled. It therefore raises the value of unarmored ships for fighting purposes; and this makes our possession of numerous unarmored and inexpensive peace vessels, and of vastly more numerous and swift merchant steamers, a source of great strength in war. (13) The effect of these conditions upon the matter of speed—which is always a vexed question—is to reduce the speed necessary in the ironclad for line-of-battle, to maintain it at about the present standard for armored cruisers, and to increase it in special vessels for dispatch service.

Sir Spencer Robinson was glad of the opportunity of corroborating the statements of the author as to the doubt and hesitation that prevailed in administrative departments with regard to naval construction, from which great danger to the interests of the country was likely to arise. It had been argued in newspapers and elsewhere that the time was come to throw off armor-plating and engage in a hopeless contest with the ironclad vessels of other countries. But they could not, for a long time to come, dispense with armor-plating. There was no doubt that ironclads had to contend with great dangers from torpedoes; but he, five years ago, and Mr. Barnaby still earlier, had urged the importance of our navy being provided with torpedoes and torpedo boats. Models and plans of such had been for a long time in the hands of the department, but they were still without that essential safeguard. Sir Spencer also complained of the length of time ships were retained on the stocks, which was not owing to the contractors, but to the naval administration. The Russians and Germans, on the other hand, showed no such dilatoriness. He was satisfied that Mr. Barnaby's plan—a combination of protection from watertight compartments, and defending the ironclads by attacking the enemy—was the right one.

Mr. Reed agreed with the last speaker in his estimate of the paper that had just been read. With respect to the latter part of his proposal he should be glad to hear the opinion of the able naval officers present. Unless they could defend the ironclads as Mr. Barnaby proposed, their use in the open sea must be abandoned.

Mr. Scott Russell said that Mr. Barnaby had removed from his mind a great load of care and anxiety. All they now wanted to obtain a fleet was will and money.

Mr. Lamport considered that the mercantile marine could supply any number of unarmored wooden ships. Torpedoes and torpedo boats could also be supplied in course of weeks, or at furthest, months, in the event of a war, in sufficient numbers by private firms.

Mr. Barnaby expressed the pleasure which the general concurrence of the meeting had given him, and endorsed Mr. Lamport's opinion with regard to the ease with which torpedo boats could be supplied when wanted.

SONG OF THE SCREW.

A MOVING form or rigid mass,
Under whate'er conditions,
Along successive screws must pass
Between each two positions.
It *turns around* and *slides along*—
This is the burden of my song.

The *pitch of screw*, if multiplied
By angle of rotation,
Will give the distance it must glide
In motion of translation.
Infinite pitch means pure translation,
And zero pitch means pure rotation.

Two motions on two given screws,
With amplitudes at pleasure,
Into a third screw-motion fuse;
Whose amplitude we measure
By parallelogram construction
(A very obvious deduction).

Its axis cuts the nodal line
Which to both screws is normal,
And generates a form divine,
Whose name, in language formal,
Is "surface-ruled of third degree."
Cylindroid is the name for me.

Rotation round a given line
Is like a *force* along.
If to say *couple* you incline,
You're clearly in the wrong;—
'Tis obvious, upon reflection,
A line is not a mere direction.

So *couples* with *translations* too
In all respects agree;
And thus there centres in the screw
A wondrous harmony
Of Kinematics and of Statics,—
The sweetest thing in mathematics.

The forces on one given screw,
With motion on a second,
In general some work will do,
Whose magnitude is reckoned
By angle, force, and what we call
The *coefficient virtual.*

Rotation now to force convert,
And force into rotation;
Unchanged the work, we can assert.
In spite of transformation.
And if two screws no work can claim,
Reciprocal will be their name.

Five numbers will a screw define,
A screwing motion, six;
For four will give the axial line,
One more the pitch will fix;
And hence we always can contrive
One screw reciprocal to five.

Screws—two, three, four, or five, combined
(No question here of sex),
Yield other screws which are confined
Within one *screw complex.*
Thus we obtain the clearest notion
Of *freedom* and *constraint* of motion.

In complex III. three several screws
At every point you find,
Or if you one direction choose,
One screw is to your mind;
And complexes of order III.
Their own reciprocals may be.

In IV., wherever you arrive,
You find of screws a cone.
On every line on complex V.
There is precisely one;
At each point of this complex rich,
A plane of screws have given pitch.

But time would fail me to discourse
Of Order and Degree,
Of Impulse, Energy, and Force,
And Reciprocity.
All these and more, for motions small,
Have been discussed by Dr. Ball.

—*Nature.*

ELECTRO-MAGNET WITH FLAT SPIRALS.

By M. SERRIN.

THE wires of bobbins of electro-magnets, used in regulators of powerful electric lights, sometimes become so hot as to fuse the insulating matter surrounding them. M. Serrin forms his electro-magnetic spirals of metallic helices without insulating cover, and so arranged that the spirals can not touch one another. He hollows out his helice from a copper cylinder of thickness equal to that of the bottom, and he covers the core with vitreous enamel. The spiral may be raised to a red heat without the sensibility of the apparatus being affected.

PHYSIOLOGICAL ACTION OF THE SALTS OF THE BILIARY ACIDS.

IT has been shown by Feltz and Ritter that bile owes its poisonous properties exclusively to the taurocholate and glycocholate of soda it contains. The same observers have recently carried out a series of experiments to determine the effect of non-lethal doses of these biliary salts on certain important functions in the dog. In such doses they render the pulse slow; they lower the arterial tension and the temperature of the body (from 1° to 2° C.); they diminish the frequency of the respiratory movements without impairing their regularity. These consequences may all be traced to a paralyzing influence exerted by the biliary salts upon the contractility both of the heart and of the voluntary muscles.

PROCEEDINGS OF THE CONGRESS OF FRENCH SCIENTIFIC SOCIETIES AT LA SORBONNE.

On Vibrations communicated to Liquids of Determined Form.—M. Barthelemy, of Toulouse, has recently studied the forms assumed by liquid surfaces under the influence of vibrations transmitted to them. A vessel of certain form, B, Fig. 1, containing mercury, is placed on the sounding-box of the tuning fork D, which when set in motion communicates to the liquid regular vibrations. In order to observe the effects produced, the surface of the mercury is strongly illuminated and projected upon a screen. A beam of light is reflected by mirror A to the mercury, which in turn reflects it to a second mirror C, which renders the beam horizontal, so that it passes through the lens E, and the amplified image falls on screen F. The vessels used are of thin glass, and

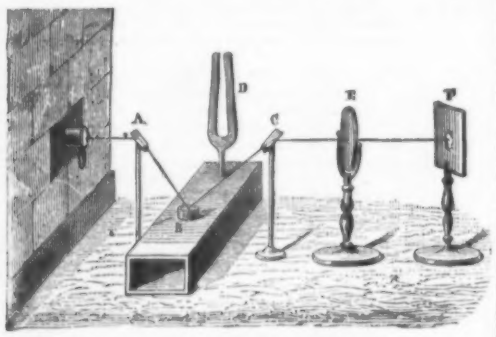


FIG. 1.—VIBRATIONS ON LIQUID SURFACES.

whatever may be their form it has been found that by vibrating successively two forks, an octave apart, the distances between the lines produced on the liquid surface by the lower-toned fork are double those caused by that of the higher key. Hence the breadth of the undulations is in inverse ratio to the vibrations. Figs. 2, 3, and 4 show the appearance of images projected from circular, triangular, and elliptical surfaces. In circular vessels a series of equidistant concentric circles are generated, and if the vase is directly touched by the fork, a double cross limiting a central space where there are no vibrations is produced. In triangular vessels the nodal lines are perpendicular to the three sides, so that a mass of hexagons is produced. The elliptical figure is the most curious yet noted. In this, in addition to several ellipses of similar focus being formed, depressions are produced which form the developed curve of the figure. Within these four branches nodal lines in form of hyperbolæ, and also the two axes of the ellipse, can be clearly distinguished.

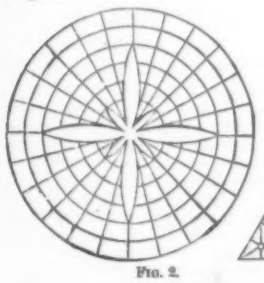


FIG. 2.

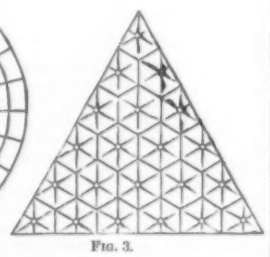


FIG. 3.

On a New Process for Separating Arsenic and Antimony.—M. Filhol notes a mode of preparation of arseniuretted hydrogen, which leads to the separation of arsenic and antimony. He prepares the hydrogen by the action of zinc on potash, and not, as is usually the case, by the action of zinc on sulphuric acid. By employing the same process with antimoniuretted compounds, he does not produce the least trace of antimoniuretted hydrogen. It is therefore possible with a mixture of compounds of arsenic and of antimony to cause the disengagement of all the arsenic in the state of combination with hydrogen, and to recover all the antimony in the apparatus. The same modification in the mode of producing hydrogen leads to an improvement in the research for phosphorus poisoning. A phosphuretted compound, formed by hydrogen produced by the action of bases and not of acids on zinc colors, flames an intense green. If zinc be replaced by aluminum the reaction is much more easily produced.

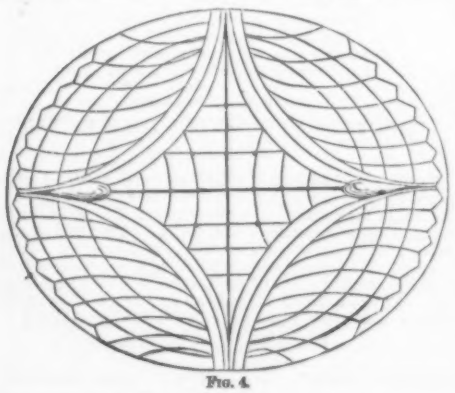


FIG. 4.

On Japanese Acid Mineral Waters.—The same author communicates the result of analyses which he has made on a very remarkable mineral water found in Japan. It was obtained from a thermal spring, or small geyser, and is of almost poisonous property. More than 15.4 grains of sulphuric acid and free hydrochloric acid are found per quart. The water is charged with sulphate of aluminum, sulphate of protoxide of iron and hydrated silica, which form deposits on the rocks. Sulphur is abundantly deposited, and the soil in the vicinity is so impregnated therewith that the inhabitants are mining it for commercial purposes.

On the Functions of Leaves.—All naturalists now make an absolute distinction between the two functions of the very different organs of vegetables, both of which, however, consist in gaseous exchanges between the vegetable and the atmosphere. One is common to all vegetable cellules, and is a function of the living part, a physical base of life in brief, denominated protoplasm. This living matter absorbs oxygen from the air day and night, and emits carbonic acid. This is the respiration of the plant. The other function is peculiar to the vegetable kingdom, and resides only in the green portion of the plants under the influence of the solar rays. In the majority of vegetables there exists, especially in the leaves, a great number of cells, of which the protoplasmic contents contains small color grains of green hue called chlorophyll. This material, under the action of solar rays, only possesses the property of absorbing carbonic acid from the air and fixing it, assimilating the carbon and emitting oxygen. During night respiration alone continues, and

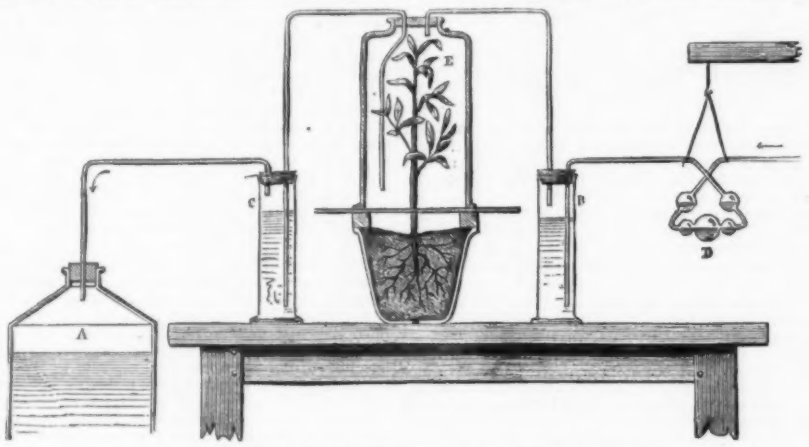


FIG. 5.—THE CHEMICAL EXAMINATION OF FUNCTIONS OF LEAVES.

plants emit only carbonic acid. M. Corenwinder has recently conducted investigations on this subject, and has devised the apparatus Fig. 5 for studying the absorption and production of carbonic acid under different circumstances. By means of an aspirator A, a current of air is caused to pass through the bell glass E, in which the upper part of the plant is contained. The stem of the latter passes through a plate of zinc, on which the bell glass rests, and around the stem as well as between the glass and plate a luting is carefully applied, so that the glass is hermetically sealed. Young shoots, in which the coloring matter is not developed when thus disposed, are shown to absorb hydrogen and to disengage carbonic acid. Green leaves, when exposed under the glass to sunlight, on the contrary, absorb carbonic acid and give off oxygen. If the white leaves of Indian corn or of white chicory be submitted to sunlight under the glass, the respiratory phenomenon alone appears. Oxygen is absorbed, and carbonic acid emitted even under strong light. This is because the white leaves, not having developed the green chlorophyll grains in their cellules, are unable to assimilate carbonic acid from the atmosphere.

On a New Combination of Hydrochloric Acid and Water.—M. Isidore Pierre, during a series of studies on refrigerating mixtures, has discovered a new crystallized hydrate of hydrochloric acid. The crystallization takes place at a temperature of —.4 Fah. The formula of the new hydrate corresponds to the combination of one equivalent of hydrochloric acid with four of water.

CHEMICAL SOCIETY, LONDON.

Dr. GILBERT, F.R.S., Vice-President, in the Chair. May 4, 1876.

"ON GLYCERO-PHOSPHORIC ACID AND ITS SALTS,

as obtained from the Phosphorized Constituents of the Brain," by Dr. J. L. W. Thudicum and Mr. C. T. Kingzett, was read by the latter. On boiling kephalin, $C_{42}\ H_{79}\ NPO_{12}$, for several hours with baryta water, a solution was obtained containing one or two nitrogenous bases, and the barium compound of glycero-phosphoric acid, $C_3H_5\ (OH_2)\ B_2PO_4,\ H_2O$. The authors then described the lead salt, the normal and acid calcium salts, and the barium salt of this acid; also an alcoholo-hydrated barium glycero-phosphate containing 20.9 per cent. of alcohol and 11.14 of water.

In reply to a question by Dr. Tilden, Mr. Kingzett explained that no compound had been found in the brain in which the phosphorus was in a lower state of oxidation than phosphoric acid.

"ON SOME REACTIONS OF BILIVERDIN,"

by Dr. Thudicum. The author, after stating that the cause of the yellow color of the skin of persons suffering from "yellow jaundice" was bilirubin, whilst the dark color of the so-called "black jaundice" was due to the presence of biliverdin, proceeded to describe some derivatives of the latter substance. *Monobrominated biliverdin*, $C_8H_8\ B\ NO_2$ was prepared by passing bromine vapor mixed with dry air over finely powdered biliverdin until it ceased to be absorbed, and the product was then heated to 100 deg. C. in a current of dry air. It is a black powder, insoluble in ether, and very little soluble in alcohol. It is soluble in sulphuric acid, but is precipitated on dilution with water. It is also soluble in caustic soda, being precipitated again in brown flocks by acetic acid. *Hydrobiliverdin* is formed on treating a solution of biliverdin in dilute caustic soda, with sodium amalgam. Its dilute alcoholic solution gives a spectrum, showing an absorption band overlying the line equilaterally, and totally different from the broad band between E and F shown by solutions of hydrobilirubin.

In reply to a question put by Mr. C. E. Groves, as to how it was ascertained that the color of the skin of a jaundiced person was due to bilirubin or biliverdin, the author said that in the case of yellow jaundice the bilirubin could be extracted from a portion of the skin by treating it with chloroform, whilst the biliverdin, which produced the color in black jaundice, could be extracted with alcohol, and the solutions were then examined by the spectroscope. He also stated, in reply to a question of the chairman, that in the forms of yellow jaundice, which were the acute cases, some obstruction of the biliary duct caused the bile to be poured out into the blood, whence it passed into the system. In chronic cases the bilirubin, after a time, became oxidized to biliverdin, giving rise to black jaundice.

"ON THE RELATION BETWEEN CHEMICAL CONSTITUTION AND COLORING POWER IN AROMATIC SUBSTANCES,"

was then read by Dr. O. Witt. In this paper the author endeavored to show that the immense variety of coloring matters was due to a clearly definable law, and also the reason why some bodies are colors, whilst others, which are sometimes isomeric with them, are not colors. In the case of nitrophenol, $C_6H_4(NO_2).OH$, and of nitraniline, $C_6H_4(NO_2)$ $.NH_2$, the coloring properties are partly due to the nitro group, but not entirely, as neither mono- nor dinitrobenzene possessed coloring powers. Only the combination of the nitro with the amido or oxy groups produced the color; and both these were able to form salts, which the nitro group could not do. In these instances the NO_2 was the coloring group, but it could only exert its influence when another acidifying or basifying group was present. He purposed to call the coloring group the *chromophor*, and the substance containing the chromopher, but not a salt-forming group, the *chromogen*. Thus, in the examples given, the NO_2 was the chromophor and nitrobenzene the chromogen of nitraniline and nitrophenol. In the important colors which were derived from azobenzene, such as "Bismarck brown," he considered the group N=N as the chromophor; asobenzene and the related bodies, such as tetrasodiphenyl, being the chromogen. It was not necessary that the chromophor should be a group containing nitrogen; the CO groups in the chromogen anthraquinone were the chromophors. On communicating salt-forming properties to anthraquinone by means or hydroxyl or amido groups, we obtained coloring matters, whilst if we deprived these groups of their salt-forming properties, by acetylation, for instance, the substances so treated lost their coloring properties.

"A NEW METHOD FOR THE PREPARATION OF THE HYDROCARBONS, DIPHENYL, AND ISODINAPHTHYL, AND ON THE ACTION AT A HIGH TEMPERATURE OF METALLIC CHLORIDES ON CERTAIN HYDROCARBONS,"

by Mr. Watson Smith. On passing the mixed vapors of benzene and antimony trichloride through a red hot tube, diphenyl is produced and in larger quantity than with benzene alone. On employing stannic tetrachloride, diphenyl is formed in large quantity, being found in the receiver in solid cakes. This is undoubtedly the best method for procuring diphenyl in quantity. Toluene treated in a similar way gives but unsatisfactory results. Where naphthalene and antimony trichloride are passed through a red-hot tube, isodinaphthyl is obtained with comparative readiness; the frequent stoppage of the tube by reduced carbon, when tin tetrachloride is employed, renders the method with antimony trichloride far preferable. The author finds that the corrected melting point for isodinaphthyl is really 187 deg. C., and not 204 deg. C. as formerly stated.

"BENZENE IN ROSIN LIGHT OILS."

In refining rosin by distilling it in a current of superheated steam, a quantity of light oils is simultaneously obtained. On examination it was found that the oils contained a large proportion of benzene, which on treatment with nitric acid yielded nitro-benzene, although somewhat impure. Recently an alteration has been made in the manner of distillation, a much higher temperature being used, and it is now found that no benzene is formed, toluene making its appearance as the lowest boiling member.

"ON THE ACTION OF WATER AND OF VARIOUS SALINE SOLUTIONS ON COPPER

by Mr. T. Carnelley, was then read by the Secretary. In his experiments the author employed thin copper foil, which he cleansed by treatment with dilute nitric acid, and washing with water. The pieces exposed one square decimetre of surface, and were treated with 100 c. c. of the liquid under examination. He studied the action of distilled water and of potassium and sodium nitrate, calcium, potassium and magnesium sulphate, sodium and potassium carbonate, sodium and potassium chloride, and ammonium sulphate, nitrate and chloride, also solutions of mixtures of salts. The copper was dissolved in all cases; but it would seem that the ammonium salts had a far more marked action than any others, on which account waters contaminated by sewage, and therefore, as a rule, containing comparatively large quantities of ammoniacal salts and chlorides, are especially bad where copper pipes, vessels, etc., are employed.

TELEGRAPHY WITHOUT WIRES.

DURING the siege of Paris experiments were tried to make use of the conductibility of the Seine in order to establish communications with the outer world in spite of the Prussian blockade. Paris, however, surrendered before the apparatus had been arranged on the Upper Seine. This scheme has not been totally abandoned, and M. Bourbouze, a *preparateur* of the Sorbonne, has tried to establish the telegraph without wire. According to M. Parville, the plan has succeeded at a small distance by expending a large quantity of electricity, not less than forty elements being required to work a magnetic needle at a distance of a quarter of a mile.

THE JETTY WORKS AT THE MOUTH OF THE MISSISSIPPI RIVER.—HEAD OF THE JETTIES.

THE GREAT JETTY WORKS AT THE MOUTH OF THE MISSISSIPPI RIVER.

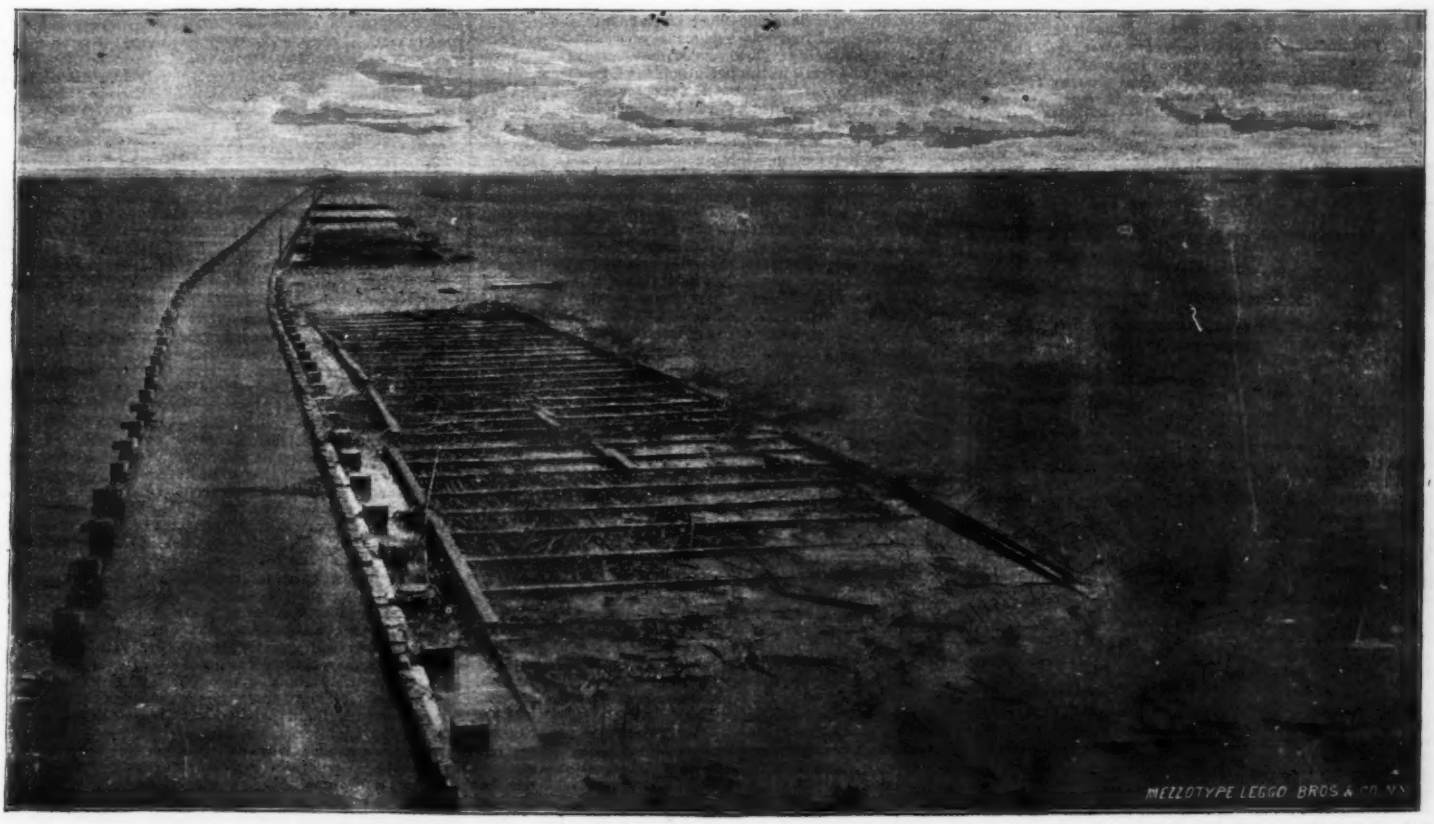
IN our SUPPLEMENT No. 21 we gave a series of drawings of these important works, planned by Capt. Eads, with description thereof by the Chief Assistant Engineer of the works, Mr. E. L. Corthell, C.E. We continue our series of illustrations by presenting herewith a couple of photographic views.

The view at the top of the page is from the top of the light-house on the west shore of the South Pass, looking across the Pass, the Gulf in the distance, the east jetty vanishing on the right. The boarding-houses of the workmen engaged on the jetties, and the wild cane of this marshy region, are seen in the foreground.

The larger engraving is a view looking south, towards the sea, and shows the South Pass between the jetties, the west jetty on the right, east jetty on the left. In the foreground is shown the arrangement of the willow mattresses and piles of which the jetties are composed. For details of construction and other interesting particulars see SCIENTIFIC AMERICAN SUPPLEMENT, No. 21. See also particulars given by Mr. Corthell before the Society of Civil Engineers, published in another part of our present number.

LIGHT WAVES.

SOME time ago an experimental inquiry was undertaken by M. J. J. Müller on a point of considerable importance in reference to our knowledge of the luminiferous ether—namely, whether in light as in the case of sound, the wave-length is dependent on the intensity, or (the same thing) the amplitude of the vibrations. He gave an affirmative answer, and said that the wave-length increases with the intensity. In view of the important issues involved, M. Lippich has recently been led to repeat the experiments, and with arrangements of greater accuracy (about 2000 times, as he estimates, more accurate than Müller's). From this investigation, of which an account appears in the *Sitzungsberichte* of the Vienna Academy, he concludes, in opposition to Müller, that the wave-length of light, whether in free ether, or in any ponderable media, is *independent* of the intensity of the light vibrations, and so, the duration of vibration being given, a constant depending only on the nature of the medium considered at rest



THE JETTY WORKS AT THE MOUTH OF THE MISSISSIPPI RIVER.—THE SOUTH PASS JETTIES.

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THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

PHILADELPHIA, June 16th, 1876.

THE American Society of Civil Engineers have just concluded their eighth annual convention, which was held in the judges' pavilion in the Centennial grounds. Without attempting to give a complete account of the interesting proceedings, some of the more prominent features may be noted.

CONTINUOUS BRIDGES.

It is well-known that a great many eminent professors have written pamphlets and treatises, to show that considerable economy can be secured by building continuous bridges, and that the bridge builders in this country prefer bridges with separate spans. The debate on this subject was not as general as had been anticipated, and resulted in the apparent triumph of the friends of the continuous system.

MAIN EXHIBITION BUILDING.

Mr. Henry Pettit explained the reasons for the peculiar design. The means of the authorities being exceedingly limited, the question was presented in the form of what kind of a building can be erected for this money, rather than how much will a suitable building cost. A comparison between the cost of straight and curved work showed that they were each about the same, but straight work was chosen, as being easier to erect, and more salable for separate buildings. In the design of the building it was considered desirable that it should have provision for extension, should offer equal facilities for all exhibitors, should be so arranged that visitors could easily find their way about, and that while there should be no galleries over exhibits, there should be a few for visitors. The first column was set on May 8th, 1875, and the building was completed in 7 months. It contains 8,340,000 pounds of iron, or 141 miles, running length. There is 1 square foot of glass to each 4 square feet of area, or 1 square foot of glass to every 20 cubic feet of capacity.

From numerous inquiries which the writer has made, he is led to conclude that this is generally regarded as being in many respects the most perfect exhibition building that has ever been erected.

IMPROVEMENT OF THE MOUTH OF THE MISSISSIPPI.

Mr. Corthill, who lately furnished an interesting account of the jetty system to the SUPPLEMENT, presented some notes of what has been accomplished since the work was commenced. The first pile was driven just a year ago, and in that time the depth of water on the bar has been increased in the shallowest part from 9 feet below flood tide to 17½ feet. In general, the deepening has taken place in even a higher proportion, the width of channel cut out varying from 50 to 350 feet. More than 2,000,000 cubic yards of material have been carried away. In order to ascertain whether this material was being deposited immediately beyond the bar, a careful survey was made of 52 acres in front of the jetty, and it was found that the average deepening had been a little more than 2 feet. The work has been exposed to several storms of exceptional severity, which have only served to render it more secure by throwing up a wall of sand. So far, there has been no action from the *teredo*.

THE METRIC SYSTEM.

Mr. Herschel presented resolutions in favor of legislation to make the use of the metric system compulsory in this country at some day to be fixed several years in advance, and supported them in an interesting speech. The Society, he thought, should take decided action either for or against the introduction of the system. The objection that the metre was not exactly the 10,000,000th part of the distance from the pole to the equator was scarcely worthy of consideration. At all events the metre was a definite length, measured on a standard bar. Some objectors say that they don't want a foreign measure, but it should be remembered that an attempt had been made to make this an international system, and that all countries had been invited to take part in its establishment. Others object to the use of French names. The names of the metric system, however, are coined in a universal language, being taken directly from the Greek and Latin. It is objected, again, that these measures differ too widely from the standards in common use. This, however, is far from being a valid objection, since in making a change the decided difference will prevent confusion. It is said that a metre rule is too large. You might just as well say that a foot rule is too small; and indeed in practice we find that most persons use a 2-foot rule. We have need of a great variety of measures, and it is an advantage to have them all intimately related. It is urged that the foot is a natural measure, being the length of a man's foot, that a yard is the length of a man's leg, and so on. Well, in the navy, shoes are ordered in lots of a thousand pair, and it usually happens that one pair of this lot have a length of one foot, and experience shows that the average length of a man's foot is 10½ inches. It was a famous king of England, he believed, who had an arm a yard long, and this was certainly an inconvenient standard, when you could not tell whether it referred to the arm or the leg. The trouble and expense of the change are mentioned among the chief objections. Well, a good thing is worth its price. The change was made in Germany, without any trouble. If you will look over the German papers of a few years ago, you will find the same objections that are now urged in this country. Here we have made the change to decimal currency with the greatest ease. If the change is going to be costly in the workshops, let the manufacturers charge for it. It will be good for trade. Thus, if new taps and dies are required, that will furnish employment to the tap and die makers. General Franklin, who is generally supposed to be an authority on guns, says he will make them with metric dimensions as cheaply as at present. The Waltham Watch Company have been using the metric system since 1869, and one of their old workmen, who has since started a shop of his own, was so impressed with the advantages of the system that he has continued its use. All civilized nations, except Russia, Great Britain, and the United States, have adopted the metric system. Why should we, who do not sell to Great Britain, but to the South American states, continue to use the British measures? The change only depends on one of the two countries, since if either makes it, the other is sure to follow.

Mr. Coleman Sillers said that the change could readily be made if it were found to be advisable. In his own shop he had used the metric system, in the manufacture of injectors, for sixteen years. The use of one system is as easy as the other, but the present standards have decided advantages. If the change is made, the cost in a shop the size of his own would be about $150,000; and, considering the number of shops in the country, it will be evident that this is a pretty serious tax upon industry, whoever pays it. In Germany the change was made for a political purpose, to obviate the difficulties arising from the variety of systems in the different States. The use of the metric system is optional in this country, and this is as far as legislation should go. If the inch is abolished, think of the change it will make in systems of gearing. Take, too, a simple example like a window, where the dimensions of the glass are in even number, such as 8 x 10, 10 x 14, and so on. Change to the metric system, and unless we would introduce fractions difficult to remember, we must alter nearly all the dimensions in common use. In the case of screw threads, the advantage of the present system is obvious; and even the Germans have not given up their old standards for screw threads, in adopting the metric system. Foreign draughtsmen, after becoming familiar with the measures of this country, use them in preference to those of the metric system. Our system possesses the advantage that the inch and foot are not only divided decimally, but also have binary and duodecimal divisions.

Professor Julius E. Hilgard stated that he had long been interested in the perfection of standards of measure, and had been largely instrumental in the passage of the act of Congress, by which the metric system was legalized in this country. From conversation with members of Congress, he was convinced that attempts to induce further legislation would be most unwise. Even the American Meteorological Society had lately passed a resolutio to the effect that it would be premature to urge legislation at present. The use of the system could easily be introduced into the different departments of the Government, but this merely required orders from the heads of departments. Its use would be very desirable in some branches of the custom-house business, as many foreign invoices were made out in metric measures, and required the services of a large number of clerks to convert them. The use of the metric system was made obligatory upon the post-office department; but it had not been adopted, on account of some mechanical difficulties in the construction of the scale. It would be well to transfer this question to the several States. Have the metric system taught in all our schools. The Anglo Saxon method is to create a custom, and then enforce it by law.

RESISTANCES OF RAILWAY TRAINS.

Mr. Shinn, chairman of the committee on this subject, read a report giving an account of some experiments made by Mr. Dudley, the inventor of the dynagraph. Railroad men were generally of opinion that a low rate of speed was most economical for freight trains; but these experiments showed that the expenditure of fuel was less for a speed of 18 miles an hour than for 10 miles. Two sets of experiments revealed a remarkable difference in the performance of two locomotives. The speed in each instance was 20 miles an hour. In the first case, the maximum grades were 17 feet per mile, and the average resistance was 7.92 pounds per ton. In the second case, the maximum grade was 40 feet per mile, and the average resistance 10.72 pounds per ton, while, owing to the superior performance of the second locomotive, the consumption of fuel per mile was about the same for each run. In one experiment, it was found that it required about as much coal to start a train as was sufficient to run the same train 2½ miles on a level. It was easy to see the importance of these experiments, and the committee hoped to continue them under the different conditions that occur in practice, until they are able to formulate the various resistances.

From the above brief record it will be seen that the Centennial Convention, so to speak, of the American Society of Civil Engineers was one of unusual interest and importance.

R. H. B.

FAST RAILWAY TIME.

ACROSS THE CONTINENT IN THREE DAYS AND A HALF.

AN unequalled feat in railroading was performed last week—one which could be accomplished in no other country than the United States—namely, the movement of a train of cars in one direction at the rate of 40 miles an hour, including stoppages, for three and a half days.

Mr. H. C. Jarrett, the theatrical manager, desirous of reaching California in the speediest possible time, chartered a train at Jersey City, which started at one o'clock on the morning of June 1st, over the Pennsylvania Railroad, bound for San Francisco, bearing twenty-five passengers. His purpose was, if possible, to reach that city in 84 hours. Among the passengers were three theatrical actors who were placarded to appear in a San Francisco theatre on the evening of June 5th. There were also on board a correspondent of the *Illustrated London News*, London *Times*, Paris *Presse*, *Journal des Debats*, New-York *Herald*, and other papers, several English gentlemen, two representatives of the English army, and others.

The time-schedule prepared for the train, which consisted of an engine, a combination baggage and a dining car, was as follows: To Philadelphia, 90 miles from Jersey City, 1 hour 45 minutes; Harrisburg, 196 miles, 4 hours; Altoona, 327 miles, 7 hours; Pittsburg, 444 miles, 10 hours; Chicago, 913 miles, 20 hours; across Mississippi River at Clinton, 2½ hours; Omaha, 1405 miles, 32 hours; Cheyenne, 1932 miles, 40 hours; Ogden, 2435 miles, 55 hours; San Francisco, 3317 miles, 84 hours.

The 90 miles between New-York and Philadelphia was made in 99 minutes, and the run to Pittsburg (444 miles) was made without making a single stop. The Alleghenies were crossed with a single engine at a speed of 35 miles an hour, the average speed being 44 miles an hour between New-York and Pittsburg. The highest rate of speed was 62 miles an hour and the lowest 25, when the train crossed the railroad bridge at Harrisburg. At the latter point, mail-bags containing copies of the Baltimore *Sun* of June 1st were received on board. The run from Jersey City to Chicago, a distance of 913 miles, was made in 20 hours and 57 minutes, and the New-York and Baltimore dailies were received and read in Chicago on the evening of the date of their publication in the Atlantic cities.

But the time made on the Eastern roads was no better than that which the train accomplished over the Northwestern road from Chicago to Omaha. In fact, it was not as good. Leaving this city at 10:30 P.M., it arrived at Clinton, on the west bank of the Mississippi, at 1 A.M., averaging a speed of 55 miles an hour, including stops, or of 58 miles an hour, deducting stops.

STATIONS.	Distance from Chicago, miles.		Leaving and arriving time.	Speed per hour between stations—miles.
Chicago		Leave.	10:30 p.m.	
Prospect Park	22.5	Leave.	10:57 p.m.	50
Junction	30.0	Leave.	11:04 p.m.	64
Rochelle	74.8	Arrive.	11:52 p.m.	56
		Leave.	11:59 p.m.	
Clinton	138.1	Arrive.	1:00 a.m.	62
		Leave.	1:14 a.m.	
Loudon	177.8	Arrive.	2:03 a.m.	49
		Leave	2:20 a.m.	
Cedar Rapids	219.4	Arrive.	3:18 a.m.	43
		Leave.	3:25 a.m.	
Boone	340.4	Arrive.	6:26 a.m.	40
		Leave.	6:31 a.m.	
Omaha	492.0	Arrive.	9:27 a.m.	53

The average speed from Chicago to Omaha, including stops, was 45 miles per hour, or deducting stops, 48¾ miles per hour. The average speed from Jersey City to Omaha, including stops, was 42 miles per hour. During a considerable portion of the distance over the Northwestern, the train passed through a heavy storm of rain accompanied by lightning. The entire run from Chicago to Omaha, a distance of 492 miles, was made in 11 hours and 1 minute. During the trip over the Northwestern one run of 75 miles in 80 minutes was made, and another of 45 miles in 44 minutes. The fastest time made on the entire route from the East was made on the Northwestern, in a short run of 2¼ miles, accomplished in 2 minutes.

The Union Pacific took up the train and sped it onward at a rate of speed in advance of that laid down on the schedule. Between Omaha and Ogden engines were changed eight times, and some time was spent in repacking the hot boxes; but the entire distance, 1032 miles, was passed over in 25 hours and 17 minutes. The fastest time from station to station was ten miles in 9 minutes, and the actual running time over the entire distance was 23 hours and 15 minutes.

From Ogden to San Francisco, over the Central Pacific, the time occupied was 23 hours and 52 minutes. Over this road difficulty was experienced from the break shoes, and two other cars were put in to break the train through the mountains. The train arrived in San Francisco in 26 minutes less than 84 hours absolute time. The arrival was greeted by the firing of guns. Not a single accident marred the trip at any point. Crowds of people greeted the voyagers as they flashed past the several towns and stations, and at night bonfires illuminated their way in those portions which are thickly settled. It is an interesting thought that if the train had gone 21 times faster than it did, it would have kept up with the sun, and would have completely annihilated time.—*Chicago Railway Review.*

AN AMERICAN ARBORETUM.

WHY is it that with an unequalled climate and soil for tree culture there is so little done in the art and science of dendrology? Why should men content themselves with a half dozen kinds of trees amidst hundreds which give variety and beauty to a plantation? Few know, and still fewer care, that our nurseries are becoming rich in shrubs and trees of great beauty, gathered from all over the temperate zone on every continent. Of the maple family alone there are some thirty to forty distinct species that will thrive in our latitude, and many of them far excel in beauty any of the familiar kinds, and some of them are exquisite to a degree which one can not imagine without actual sight. Of pines there are more than forty species suitable to our climate, after throwing out the dwarfs and pigmies, thirty oaks, twenty-five firs, an equal number of junipers, fifteen ashes, ten or twelve elms, and of other trees, large or small, and shrubs, an almost endless catalogue, some of the finest and hardiest of which are seldom seen except in the grounds of a half dozen connoisseurs. Besides the species recognized as regular, there are scores, and soon will be hundreds, erected from "sports" into "varieties" on account of some peculiarities, such as the color of leaf, the strange divisions of the leaf, or some drooping of the branches. Of these kinds are some of the most beautiful trees for ornament which can be found, such as the weeping beech, the purple beech, the purple birch, the cut-leaved alder, cut-leaved beech, the tri-colored maple, the aucuba-leaved ash, etc., etc.

The parks of our great cities afford a rare opportunity to place before the community specimens of every kind of tree that will flourish in our climate. To a small extent this has been attempted. But there are no catalogues which furnish a stranger with the list, and no chart by which he can readily find any desired specimen, and no labels by which he can interpret any strange tree or shrub upon which he may chance to stumble. Upon the very beautiful park grounds in Albany one finds a few magnificent elms, of age, but the new plantations seem made up of a few kinds reproduced endlessly. The Norway spruce usurps the place of almost the whole family of coniferous evergreens. It is true that our inspection was cursory, and that we may have overlooked many specimen plants; but the impression produced by a ride through it was that the grounds were beautiful, well treated as to form, but with scant variety and very meagre as to rare ornamental kinds.

Central Park in New-York, Prospect Park in Brooklyn, are

in advance of any others in the range of species and varieties of ornamental trees. The Great Park of Philadelphia, which leads all others in extent and variety of ground, ought to be made the wonder of the world in its rich variety. For Philadelphia has a climate which may be regarded as the perfection of dendrological climate. Besides, this city has already a fame in the old Bartram Garden that should not be lost, but augmented, and in many private grounds, on which may be seen, probably, the oldest and grandest specimens, full-grown, of some of our noblest trees.

On a recent visit to Cornell University, at Ithaca, N. Y., we were so favorably impressed with the grounds as a site for an *Arboretum*, that we could not help calling the attention of those eminent nurserymen, Ellwanger & Barry, of Rochester, N. Y., to the propriety of establishing there a model plantation of all hardy trees. At a subsequent visit to their grounds in Rochester, these gentlemen informed me that the subject was favorably regarded, and that they should soon go over and inspect the grounds and see what arrangements could be made. Certainly no other gentlemen could have been better selected who unite in themselves the scientific knowledge, the experience, and the professional ability to make a great collection. It would be a laudable ambition on the part of any person to unite his name to this great University of the future by surrounding it with groves in which the thousands of coming young men might become familiar with whatever of trees and shrubs the temperate zones of the world have that is beautiful or useful.—H. W. BEECHER, *Christian Union*.

APPARATUS FOR DEMONSTRATING THE TRANSFORMATION OF FORCE.

IN a recent number of the *Journal de Physique*, M. Crova describes a convenient apparatus for showing the relations between heat, electricity, and mechanical force. The arrangement is as follows:

Two of Clamond's thermo-electric generators are connected in surface, and put in communication with a Gramme machine in such a way as to set this in action. In the circuit is inserted a sort of electric lamp, in which a platinum wire placed in the centre of a small globe (which protects it from agitation of the air) can be raised to incandescence. The only difficulty of the experiment consists in so regulating the length and diameter of the platinum wire as that it may be raised to a red heat, while the thermo-electric current retains sufficient intensity to drive the Gramme machine. A circuit entirely metallic then is obtained, with which the following transformations can be effected:

1. The Gramme machine being excluded from the circuit, a portion of heat, transformed into electricity by the thermo-electric pile, reappears in the state of heat in the platinum wire.

2. The platinum wire being excluded from the circuit, and the Gramme machine introduced, a portion of heat, transformed into electricity in the pile, produces mechanical work in the machine, which acts as a motor.

3. The platinum wire and the machine being included in the circuit, a part of heat, transformed in the pile into electricity, produces heat in the wire and work in the motor. If we then stop the motion of the Gramme machine, we find the incandescence of the platinum wire increased. The machine being liberated, on the other hand, is set agoing again, and the incandescence of the platinum wire diminishes in proportion as the motion is accelerated. In this way is rendered sensible to the eye the expenditure of heat necessary to develop an increasing quantity of mechanical work.

4. Taking the handle of the machine, we turn it *in the direction* of the rotation the current produces, but with an increasing velocity. In this way a velocity is reached such that the incandescence of the wire *completely disappears*.

5. If the handle be turned in a direction opposite to that of the rotation the current communicates, there is considerable resistance, and the incandescence of the wire *increases* rapidly; on turning more quickly, the wire is fused. Thus, in the metallic circuit under consideration, the circulation of a given quantity of energy may appear exteriorly in the form of heat or of mechanical work, the one of these quantities being the complement of the other. If by an exterior force we introduce into the circuit an additional quantity of work, the increase of the quantity of energy put in circulation is rendered visible by the incandescence of the wire; any communication outwards from the circuit, of a certain quantity of energy which circulates in it, appears, on the other hand, in diminution, or even disappearance, of the incandescence.—*Nature*.

WARNING OF EXPLOSIVE OR DELETERIOUS GASES.

MR. ANSELL has devised an apparatus for indicating the presence of the smallest quantity of explosive or deleterious gas in any mass of air, however large. It is known that when two gases are separated by a membrane or porous partition, they tend to mix by endosmose, but the velocity with which the movement takes place varies for different gases, and is found to be inversely as the square roots of their densities. It follows, from this law, that if two gases of different densities are separated by a porous partition, they mix by passing through the partition, but the less dense gas will penetrate into the space occupied by the denser far more abundantly than this latter will escape. There will, consequently, be an increase of pressure in the space it occupies. A first indicator is composed of a metallic barometer, inclosed in a brass box, the bottom of which consists of a porous earthen material. If the box is placed in an atmosphere containing proto-carbonate of hydrogen, or any other gas less dense than air, this gas will filter through the porous partition into the box, and the quantity which enters will be greater than that of the air which escapes. Hence there will be an increase of pressure in the box, and the barometer will come under the influence of that pressure. If the barometer is placed in an atmosphere containing carbonic-acid gas, or any other gas denser than air, it will be affected in a contrary way. The air in the box and the carbonic-acid gas will mix by filtering through the porous partition, but the quantity of air that goes out of the box will be greater than that of the carbonic-acid gas that goes in. Consequently, there will be a diminution of pressure, which will tell upon the barometer. Hence, it is evident that such an apparatus placed in the gallery of a mine might warn the miners of the presence of proto-carbonate of hydrogen, but they must observe the barometer to become aware of danger. This is a serious drawback, which Mr. Ansell endeavored to remedy by a further contrivance. It consists of a small tube bent into the form of a U, one of the branches of which ends in a funnel closed by porous earthenware. The tube contains mercury, and in ordinary circumstances, when the apparatus full of air is placed in pure air, the surfaces of mercury in the two branches are on the same level. But this is not the case when the air is vitiated by proto-carbonate of hydrogen. This gas will filter through the earthen partition, penetrate into the funnel, increase the pressure, and make the column of mercury rise in one branch of the bent tube so as to cause a contact between two platinum wires, which terminate in the two poles of an electric battery. The current is thus established, and if an electric bell is placed in the circuit, a signal will be given, which can be conveyed to any distance. The apparatus being placed in the gallery of a mine, and put in communication with an electric battery, as soon as the combustible gas escapes from the subterranean cavities, it makes the bell sound, which may be placed out of the mine in the engineer's office. Though not yet extensively used, this apparatus has been attended with favorable results in several coal mines.

SULPHUR BEDS OF WASHOE COUNTY, NEVADA.

A REPORTER of the Gold Hill *News*, who not long since visited the recently discovered sulphur beds, situated at the base of the mountain, one and one half mile west of Steamboat Springs, in Washoe County, gives the following facts and conclusions: The sulphur belt was discovered a few months since by Thomas Wheeler and Isaac Spencer, of Reno, who were prospecting in that section for cinnabar. The deposits have been opened by cuts and shafts at different points, extending north and south for a distance of half a mile or more. The sulphur is embedded in a light-colored, chalky appearing formation, strongly resembling steatite, which formation is half a mile in width, and can be traced northerly and southerly for at least a mile, and, judging from the general surface appearances, it is reasonable to suppose underlies the whole extent of the magnesian formation. The sulphur has been found in the most of the shafts and cuts a very few feet below the surface. On the surface no escapes or indications of heat are visible, but in all the cuts and shafts great heat, steam, and gas have been developed a very few feet below the crust. The principal claim, known as the Wheeler & Spencer, has been leased to James Duffy and Thomas Smith, of Carson City, for a term of three months. These gentlemen have commenced the opening of the sulphur deposit on a point of the mountain, some 150 feet above the level of the flat, having secured, for a foreman of the works, the services of Mr. Joseph Scott, who is probably the best posted sulphur miner and prospector in the State. Mr. Scott opened the famous Rabbit Hole Mine in Humboldt County, and has been a steady prospector in that line for several years past. The mine at that point has been opened to a depth of 20 feet by running open cuts into the hillside wide enough to turn a horse and cart. The cuts show the sulphur to lie in crystallized bunches and streaks, intermixed through and through the talc, or magnesian bed. Five or six tons of sulphur have been extracted, and lay piled up ready for shipment, and some fifty tons more were stripped, almost ready for extraction. At the bottom of the pit the heat was great enough to ruin the soles of a man's boots who would dare to linger there any length of time, and the sulphurous gases and steam made it a very uncomfortable place in which to labor. The appearances show, beyond a doubt, that a large and paying deposit of sulphur has been found. The sulphur, in its raw state, just as it is extracted from the mine, assays about 75 per cent of the pure article, and is worth in the San Francisco market $50 per ton. These beds are within easy reach of the railroad, and, if it is desirable, a side track can be easily constructed almost to the mines.

These hot, steaming beds of brimstone undoubtedly furnish a natural clue to the causes that operate the famous Steamboat Springs, a mile and a half to the eastward. The formation underlying the sulphur beds is undoubtedly an immense ledge of magnesian limestone, filled with veins of iron, sulphur, and other minerals. Immediately in front, and overlying this bed of minerals, is a mountain of hard, syenitic granite. Back of it the mountain rises quite abruptly, and there is but little doubt that some of the small lakes formed by the melting snows on the table-lands above find outlets through the open rocks into this bed, thus producing a decomposition of the minerals and releasing the carbonic acid in the limestone, which creates the powerful heat of the springs. The minerals are thus sublimated, and afterward condensed by the cold near the surface and left in the state in which we now find them. The first dip of the stratum, at the base of the mountain, is quite steep, and the flow of water following the strong inclination of the rocks evidently passes underneath the belt of syenitic granite in front, and finds an outlet through the fissures and seams in the soft rocks beyond. The damming or closing up at times of these escape-valves no doubt often confines the sublimated minerals and superheated steam to such an extent that it is forced to the surface with great power, which readily accounts for the mysterious exudation of the sediment and waters which so often takes place so forcibly, and has attracted so much attention from visitors.

ASTRONOMY.

ON THE DISTRIBUTION OF THE ASTEROIDS.*

By DANIEL KIRKWOOD, of Bloomington, Indiana.

NEARLY twenty years since, when the number of known asteroids was less than fifty, it was inferred from physical considerations that great irregularity must obtain in the distribution of these bodies, and that gaps or chasms would be found in those parts of the zone where the periods of asteroids would be commensurable with that of Jupiter. To verify this theory every addition to the group was watched with interest. In 1866, when the number had increased to eighty-eight, the agreement between theory and observation had become so marked that I ventured to call attention to the fact in a paper read at the Buffalo meeting of this Association. The comparison of fact and hypothesis has been continued to the present time; the latest summing up of results having been made at the Indianapolis meeting in 1871. Within the last four years thirty-one members have been added to the cluster; and it is now proposed to show that these recent discoveries more clearly than ever illustrate the truth of the theory suggested in 1866.

The difference between the greatest and least mean distances is 1.28, and as 146 members of the group are now known, a uniform distribution would give 0.0088 as the average interval between consecutive orbits. The entire zone contains the following distances at which the periods of minor planets would be commensurable with that of Jupiter:

(1.) 3.27;	where 2	periods	would be	equal to	1	of Jupiter.
(2.) 2.25;	" 7	"	"	"	2	"
(3.) 3.47;	" 11	"	"	"	6	"
(4.) 2.50;	" 3	"	"	"	1	"
(5.) 3.03;	" 9	"	"	"	4	"
(6.) 2.95;	" 7	"	"	"	3	"

Now, when the members of the group are arranged in the order of their mean distances, it is found that the widest intervals are at the distances above given. Thus

At 3.27	the interval is	0.1628, or 18	times the mean.
" 2.25	"	0.0632, or 7	"
" 3.47	"	0.0620, or 7	"
" 2.50	"	0.0577, or 6½	"
" 3.02	"	0.0573, or 6½	"
" 2.95	"	0.0566, or 6	"

It seems impossible to regard the foregoing as casual coincidences. I have elsewhere assigned a physical cause for the facts observed—a cause believed to be adequate both in mode and measure.

Of the thirty-one asteroids discovered during the last four years but one, according to the published elements, is found in a gap previously indicated. This is No. 139, which is assigned by the elements of Doolittle and Wilson* to that portion of the zone in which five periods would be equal to two of Jupiter. If these elements are correct, the period of this asteroid has the same ratio to that of Jupiter that the latter has to the period of Saturn. As the observations, however, from which the planet's elements were derived, extended only from the 10th to the 17th of October, the mean distance given may be considerably modified. In this case the chasm remaining about the distance 2.82 will be five times greater than the mean interval.

The marked irregularity in the distribution of asteroids throughout the zone is presented at one view in the following table:

Interior to the distance 2.26.....	2 asteroids.
from 2.26 to 2.36.....	7 "
" 2.36 to 2.46.....25	"
" 2.46 to 2.56..... 5	"
" 2.56 to 2.66.....20	"
" 2.66 to 2.76.....28	"
" 2.76 to 2.86.....13	"
" 2.86 to 2.96..... 4	"
" 2.96 to 3.06..... 4	"
" 3.06 to 3.16.....13	"
" 3.16 to 3.26..... 5	"
" 3.26 to 3.36..... 0	"
Exterior to 3.36.....	4 "

In three portions of the ring the clustering tendency is here distinctly evident. These are from 2.36 to 2.46, from 2.56 to 2.76, and from 3.06 to 3.16. We have thus an obvious resemblance to the rings of Saturn; the partial breaks or chasms in the asteroid zone corresponding to the well-known intervals in the system of secondary rings.

It is a remarkable fact in the development of the solar system that the largest planet, Jupiter, should be succeeded by a space so nearly destitute of matter as the zone of asteroids; the ratio of the masses being that of 1 to 5180.† An explanation of this striking disproportion was suggested in the Proceedings of the American Philosophical Society, for August 19, 1870. In view of the facts above presented, however, it seems pertinent to ask,—What *would have been the results* of Jupiter's influence on the zone, had the density of the latter been equal to that of other planetary rings?

As the periodic time of nebulous masses at the distance 3.27 from the centre of motion was precisely one half that of Jupiter, the influence of the exterior planet would give increasing eccentricity to their orbits. The disturbed matter would, therefore, be brought into contact, either with exterior parts of the ring, in aphelion, or with interior portions, in perihelion. A number of planetary nuclei would thus be formed, whose mean distances would differ but little from 3.27. These nascent planets, revolving in the same direction, and receiving gradual accretions of matter, would move with slightly different velocities. Collisions would therefore follow, until finally all would be collected into a single mass, whose period would be approximately half that of the disturbing planet. Such a result, though prevented in the asteroid zone by its extreme rarity, was realized in the case of Uranus. A similar formation would have taken place where the period of a planet would be nearly one third that of Jupiter, corresponding to the ratio between the periods of Uranus and Saturn. Planetary aggregations might have occurred at intermediate distances, but in such case the close proximity of considerable masses would have resulted in collisions and "the survival of the fittest."

The inclinations of about three-fourths of the asteroids known are less than 10°, and but three have inclinations greater than 25°. When we consider the great number of these bodies, together with the fact that in their primitive, gaseous form their dimensions must have been much greater than at present, it seems not improbable that collisions may have occurred between comets and asteroids. The masses of the former are doubtless in some cases comparable to those of the latter. In the event of such impact, therefore, the direction of the planet's motion might be very much modified. Possibly the rare instances of great inclination may thus be explained.

* Read at the Detroit Meeting of the A. A. A. S., 1875.

* *Astr. Nach.*, No. 2069.

† Adopting Alexander's mass of the Asteroids. See Smithsonian Contributions to Knowledge, No. 280, p. 33.

REACTION-TIME OF THE TASTE.

THE time elapsing between the action of an external stimulus on some part of the body, and the giving of a signal (previously agreed upon) in reply, has been determined in the case of several senses, by various experiments. A short time ago MM. Vintschgau and Hönigschmied sought to determine this "reaction-time" for sensations of taste on the point of the tongue; and in the subject experimented on, this was found to be, for ordinary salt, 0.1598"; for sugar, 0.1639"; for acid, 0.1676, and for quinine, 0.2351". It is interesting to compare the results which the same observers have recently obtained in further experiments as to the reaction-time for sensations of touch on the tongue. This, in the same individual, was found to be 0.1507" in the case of the tongue being torched with a pencil; a smaller value, therefore, than that of the shortest interval in the former case of taste. In the middle of the tongue the reaction-time, on touching with a pencil, was 0.1527". A weak electric stimulation of the tongue-point was answered after 0.1813", whereas with a stronger electric stimulus the answer came in 0.1452". These numbers represent, in all cases, the averages of all the experiments. It will be seen, then, that the point of the tongue is most sensitive for strong electric stimuli, and the order of sensibility for the remaining stimuli, was (for this individual): Contact, saltness, sweetness, sourness, weak electric stimulation, and bitterness. Other persons on whom similar measurements were made, gave values that were different both relatively and absolutely, and the results for different persons appear to be not comparable together. Various secondary influences play an important part, among which may be cited the thickness of the mucous membrane at the particular part experimented on; this may considerably increase the reaction-time.

DETAILS OF COMPOUND ENGINE WITH ASHWORTH'S VARIABLE EXPANSION GEAR.

WE give on the present and opposite pages engravings of a pair of compound engines which drive the mill of Mr. John Ashworth, of Astley Bridge, Bolton, England. The engines, which are shown in plan and elevation on the opposite page, are of the horizontal type, and were recently compounded on the tandem principle, the cylinders, which are not steam jacketed, being respectively 18 in. and 34 in. in diameter, and 5 ft. stroke. The engines make 47 revolutions per minute, and the pressure in the boilers is about 73 lbs. per square inch.

The principal novelty about the engines is the arrangement of the expansion gear applied to the high-pressure cylinders, the governing of the engines taking place through this expansion gear, and no throttle-valve being used, so that very nearly the full boiler pressure is obtained on the high-pressure pistons. The arrangement of expansion gear is one patented by Mr. John Ashworth, the proprietor of the engines, and is a modification of the Meyer gear, the screws by which the expansion plates are adjusted being, however, outside the valve box, where they can be properly lubricated, and where they are removed from the grinding that usually takes place in high-pressure steam.

The details of the arrangement are shown by Figs. 5 and 6, above, from which it will be seen that each cut-off valve d has an independent spindle d^2, the spindle of one expansion valve being above the centre line of the main valve, and the other below. At the crosshead (which is worked by an eccentric in the usual way) are two spur wheels geared together, as shown by the enlarged views, Figs. 7 and 8. These wheels act as the nuts to the screwed part of the valve spindles d^2, the spindles being kept from revolving with the nuts by square guides in the crosshead. Into one of the spur wheels, just mentioned, a third wheel, g, is geared, this wheel being carried along with the crosshead, and deriving its revolving motion from a shaft f^3, having a square formed upon it, and working through the eye of the wheel. This shaft is turned by the aid of gearing and by friction bevel wheels from the governor spindle, the arrangement being shown by Figs. 5 and 6.

The governor is of the cross-armed description, and runs at 150 revolutions per minute. Its mode of operation is as follows: So long as the engine is working at its proper speed the bevel discs e^1, e^2, on the governor spindle (see Figs. 5 and 6) remain out of contact with the bevel friction pulley f situated between them, and consequently the shaft f^1, f^2, and pinion, g, are not turned round, and the expansion valves d d remain at the distance apart which is due to the load on the engine. On the other hand, when the governor balls expand owing to an increased velocity of the engine, the bevel disc e^2 is raised into contact with the friction pulley f, thereby starting the shafts f^1, f^2, and pinion g, which gears into the lower pinion d^2 (see Figs. 7 and 8); the pinions d^2 being thus turned round and in opposite directions cause one of the screws d^2 to be screwed into one of the pinions d^2, and the other to be unscrewed out of the other; the cut-off valves are thus made to recede from each other, thereby cutting off the steam earlier, and admitting less steam to the cylinder. When the engine is running too slow, on the contrary, the bevel disc e^1 comes in contact with the friction pulley f and drives the shaft f^1, f^2, in the contrary direction, thereby moving the cut-off valves and increasing the amount of steam admitted to the cylinder. By this means the position of the cut-off valves is varied according to the load, and in the case of the particular engine we illustrate, the cut-off can be varied from 0 to 80 per cent of the stroke.

The low-pressure cylinders of the engines under notice are fitted with slide valves at each end, worked by an eccentric and made to cut off at about ½ stroke, the communication from the high to the low-pressure cylinders being as direct as possible. The condenser is placed as close as possible to the low-pressure cylinders, the communication from the condenser to the air pump being made by 16-in. pipes. The air pumps are worked through the drag shafts from the crank-pins, and the guiding of the air-pump rods is effected by parallel motions.

The fly and spur driving wheel of these engines is of somewhat unique design. As shown by the detailed views, Figs. 3 and 4, the arms and the boss are cast together, but in two halves, and are held together by turned and bored hoops shrunk on, the boss being turned to receive them. The fly rim is also in two halves, held together by hoops shrunk into recesses cast in the rim. The spur rim, which is 15 ft. 1½ in. in diameter, 6 in. pitch, and 15 in. wide, is in one casting, and is turned to fit upon the arms; the whole weight of the wheels is about 34 tons.

The results obtained by these engines are very satisfactory. The consumption of coal, as found by a series of tests made by Mr. R. B. Longridge, is 2.13 lbs. of Lancashire coal per indicated horse-power per hour, the boilers being ordinary Lancashire boilers with three Galloway tubes in each flue, and with a Green's economizer to heat the feed water. The Lancashire boilers are 30 ft. long by 7 ft. in diameter, and have flues 2 ft. 10 in. in diameter, with three Galloway tubes in each. The firegrates, when the above-mentioned results were obtained, were 6 ft. long, giving an area of 34 square feet for each boiler. Two boilers were used during the trial, and the coal burnt was "Clifton 4 ft. mine," free from small.

The governing of the engines is also found to be very satisfactory. At present the engines are indicating about 520 horse-power, but are calculated for driving 650 to 700 horse-power. The set of indicator diagrams in the preceding column are reproduced from Mr. Longridge's report, and show how closely the boiler pressure is reached in the cylinders. We should state, too, that we have in our possession other diagrams from these engines, showing a difference of only 1½ lbs. between the boiler pressure and the initial pressure in the cylinders, the boiler pressure having in this case been ascertained by applying the same indicator as was used on the cylinders, so as to correct the errors which sometimes arise in making such comparisons from trusting to the indications of a pressure gauge. The diagrams also show that the steam has a very free passage from the high to the low pressure cylinders, the loss by throttling being very slight.—*Engineering.*

Fig. 1.

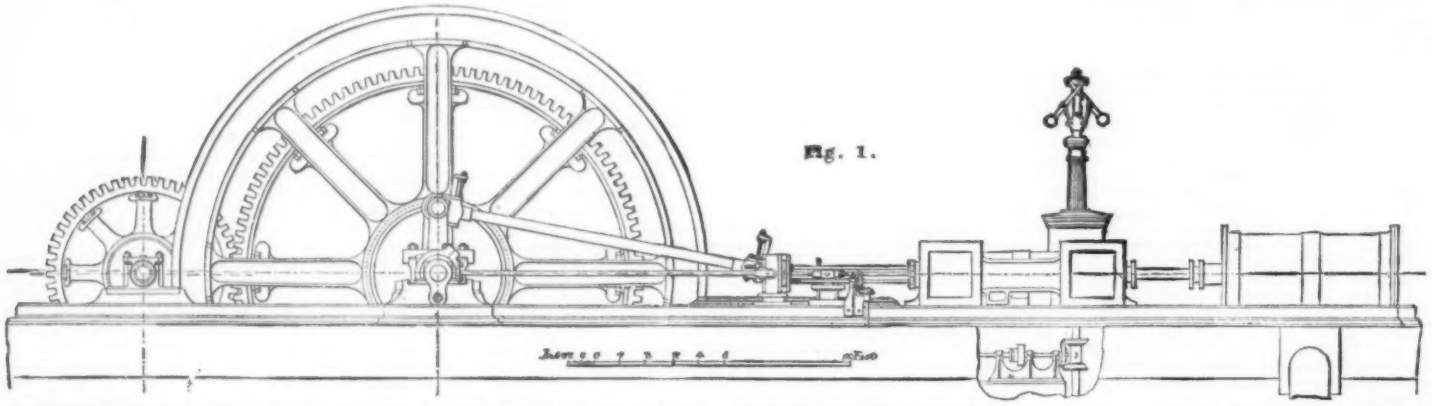
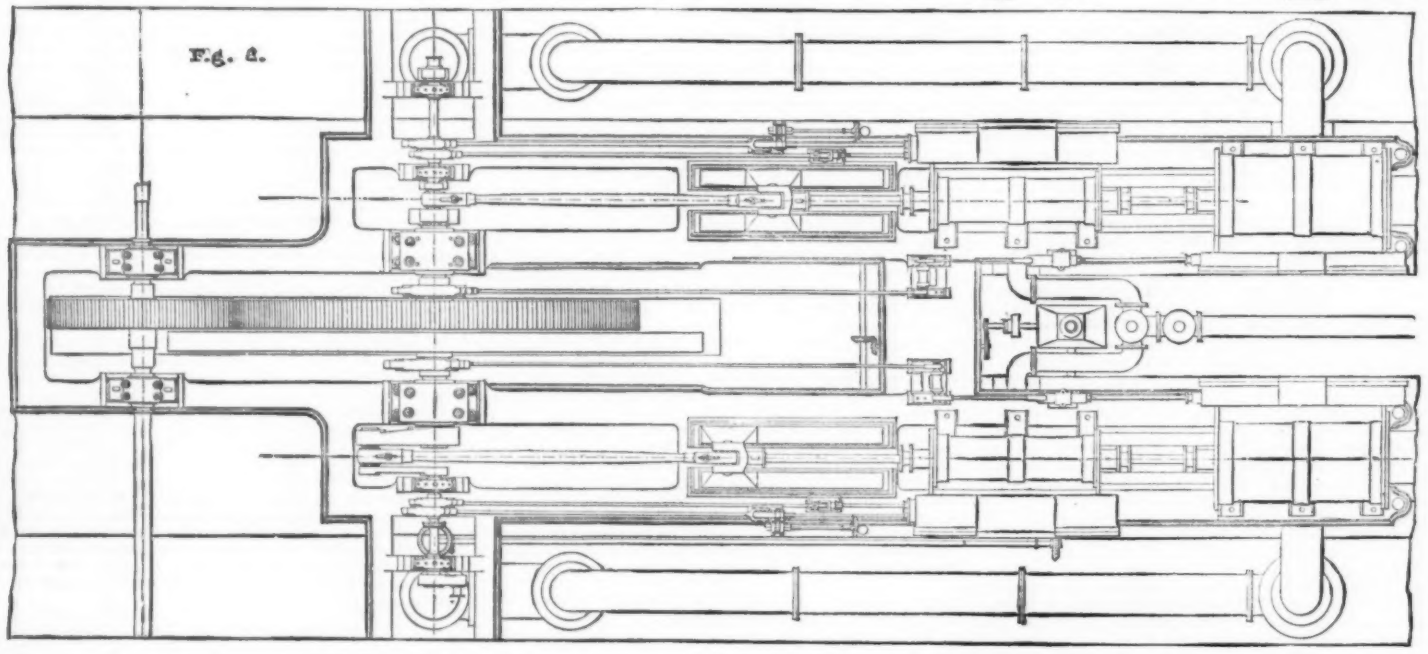


Fig. 2.



COMPOUND ENGINE WITH VARIABLE EXPANSION GEAR.

A HUNDRED-TON GUN.

SIR WILLIAM ARMSTRONG has nearly completed the first of his hundred-ton guns for the Italian Government. It will be bored to 17 inches calibre, as originally intended, and polygrooved, the projectile being rotated by a sort of gas-check at the base.

STEAM STREET-CARS.

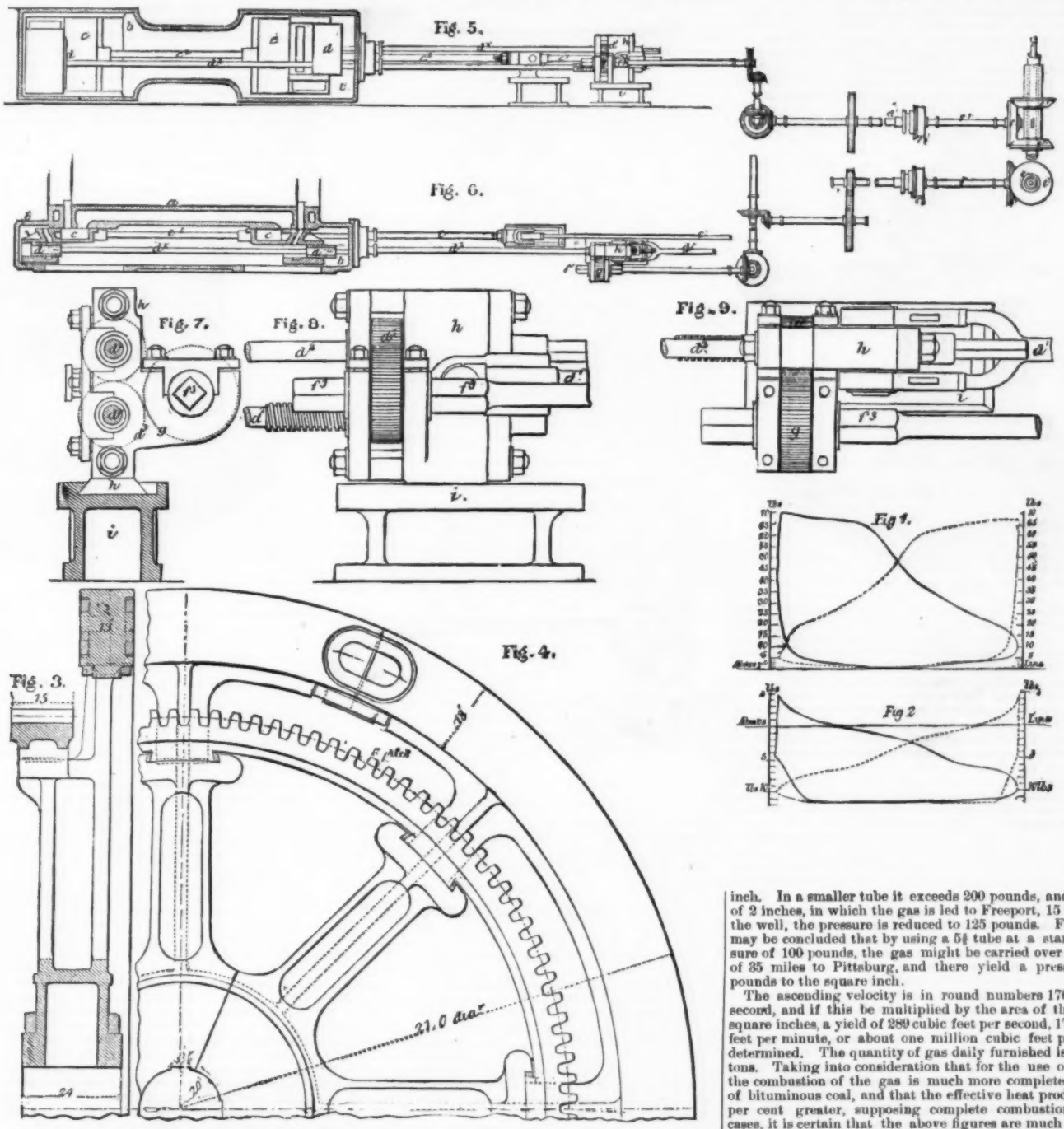
A TRAM ROAD takes an intermediate position between a common paved or macadamized road and a railway. The resistance of a tram road in moderately good condition is less than that of the best common road, but much greater than that of good permanent way. On this last, at moderate speeds, and with wheels not less than 3 ft. high, the resistance is about 9 lbs. to 10 lbs. per ton—sometimes less, seldom more. On a fair common road the resistance is about 60 lbs. per ton. Very few experiments have been made to test the resistance of street tramroads, but we have certain facts which bear on the subject which are available for use in an attempt to arrive approximately at the required information. The gross weight of a tram car carrying thirty passengers may be taken as four tons. This is easily drawn, and at a fair pace on a level, by two moderately good horses. The joint pull of these horses, under the conditions, will not exceed 150 lbs. This gives a tractive resistance of about 37 lbs. per ton. It is possible that the resistance may be a little less than this, but it would be unwise to reckon on a smaller resistance than 40 lbs. per ton. It may be asked how is it possible that such a difference exists between a tram road and a railway? The thing is easily explained. Tram-car wheels are much smaller than those used on railways, and tram rails are never as clean as those traversed by an ordinary train. A little dirt on a rail will enormously increase its resistance to the rolling of a wheel on its surface. Inclines of 1 in 20 are met with on tram roads. The length of the incline may be very small, but a steam tram car may be stopped on it, and should be able to start again. This will add a resistance of 448 lbs. We have thus a total of, say, 600 lbs. as the least tractive effort which it will be safe to provide for the haulage of a loaded tram car. A pair of horses are quite competent to exert this strain for a few yards if they have good foothold. It will not be wise to assume that an engine competent to draw a load of 4 tons under the conditions stated, will itself weigh less than 4 tons, with sufficient water for condensing purposes in the tanks. The car and engine together will thus weigh 8 tons, and require for the propulsion sufficient power to overcome a resistance of 1200 lbs. This does not represent the average work, but the maximum effort of which the engine should be capable. The whole weight of 4 tons of the locomotive being available for cohesion, we have $\frac{8960}{1200} = 7.4$ as the least possible coefficient of it that will suffice, which is probably enough, but certainly not too much. We believe that the figures on which our calculations are based are sufficiently accurate; and for this reason we are of opinion that, except for use on very level lines, no steam tram car is likely to succeed which has a smaller load than 4 tons on its driving wheels. Even on lines which are dead level it is important that a tram car should be able to start off rapidly, and to this end the tractive power must admit of being increased by four or five times over that which will suffice in ordinary work.

We can now estimate the horse-power which will be required. Let us assume that the average velocity is six miles an hour, or 528 ft. per minute, the resistance 350 lbs., the total weight moved being 8 tons. Then $\frac{350 \times 528}{33000} = 5.6$ indicated horse-power. This is probably over the mark, but

the error is on the right side. Adding 1.4 horse-power for engine friction, we have a total of 7 indicated horse-power. Such engines as will be used in tram cars will consume 50 lbs. of steam per horse per hour. Thus 350 lbs. of feed-water must be carried for an hour's run. The quantity of condensing water needed will amount to about eight times as much if its temperature is at no time to exceed 180 deg. Therefore, the engine-tanks must hold 280 gallons, weighing nearly a ton and a quarter. We have assumed here that the gradients are compensating, so that although steam may be used at a much quicker rate than 350 lbs. an hour at one time, it will be used less rapidly at another; but this can not possibly hold good if the run is up hill almost continuously one way. Circumstances will seldom occur under which a tram car can carry less than an hour's supply of condensing water, and this fact should never be forgotten.

It would be impossible here to go into any minute details concerning the construction of the machinery of steam tram cars. It must suffice to state that a boiler of ample dimensions should always be adopted; that the fire-box, especially, should be very large, and that the rate of combustion should be moderate. Then the furnace will go without attention for at least half an hour at a time. Express trains are now run from London to Brighton with a single fire, no coal being put into the box between the two termini. If this is possible on a railway, it should be possible to traverse three miles on a tram road without firing up. If really good and *clean* coke is used, air being admitted above the burning fuel to consume the carbonic oxide evolved, no trace of smoke will issue from the funnel. If the steam is condensed rapidly enough, no vapor will escape. To prevent the escape of smoke and steam is purely a matter of detail, easily settled by a competent engineer with a practical knowledge of his subject. We have said sufficient, we think, to prove that tram cars are not toys, and that toy engines can not be employed to propel them. On occasions, indeed, the propelling machinery will have to exert as much as 20 horse-power indicated, and the dimensions of all the working parts should be proportioned accordingly. If attention is paid to these matters, and the magnitude of the work to be done is not underrated, there is no reasonable doubt that steam tram cars will prove perfectly successful. Whether, in the long run, they will in this country prove much cheaper than horse-worked cars we shall not attempt to say.—*The Engineer.*

COMPOUND ENGINE WITH VARIABLE EXPANSION GEAR.



THE GAS WELLS OF PENNSYLVANIA.

By Prof. J. LAWRENCE SMITH.

[The following report on the present condition of the Pennsylvania gas wells has recently been transmitted by Professor Smith to the French Society for the Encouragement of National Industry, of which he is a corresponding member.—EDS.]

Situation.—The principal wells are situated in Butler County, latitude 40° 30′, longitude 80°. Wells of less importance are also found in neighboring counties. It has been known for several years that on excavating to certain depths in these regions, gas escapes with violence, but the practical advantages which result from this phenomenon have not attracted serious attention until within the last few months. The most prolific wells are those known under the names of the Burns and the Delamater.

Burns and Delamater Wells.—These are separated by at least half a mile, and are located in Butler County, seven miles northeast of Butler, and about fifteen miles from the Harvey wells (Larden's Mills, same county), of which the gas is conducted to Pittsburg, to the works of Spang, Chalfant & Co., and Graff, Bennett & Co. The two wells are located about thirty miles, measured in a straight line, from Pittsburg. Their depth is about 1600 feet, for they are bored down to the fourth sand stratum, so well known, at least by name, to those engaged in the petroleum production. The Burns well, it is believed, has never yielded oil, but the Delamater, first carried to the third sand layer, was a petroleum well at 1600 feet. Sunk afterward to the fourth stratum, it gave gas at such a pressure that sounds of about 1760 pounds weight may be withdrawn by hand. Each well is 5⅛ inches in diameter.

The Delamater well is the most remarkable. It produces nearly double the gas of the Burns, and furnishes light and fuel to all the vicinity, including the village of Saint Joe. It is situated in a valley surrounded by high mountains, which reflect and concentrate the light of the ignited gas. Many conduits start from the well; one leads the gas directly to the cylinder of a strong motor, which by its pressure alone acquires a prodigious velocity, and if the gas at the exhaust of this be lit, an immense flame is produced. Another pipe feeds a second flame, capable of reducing as much iron ore as half the furnaces in Pittsburg. At 64 feet distant is the principal escape orifice of the well. From a tube 3 inches in diameter, a column of fire, 40 feet high, shoots forth with a roar that fairly makes the hills tremble. Over a radius of 50 feet around the earth is scorched, but farther away the vegetation is as abundant and as vigorous as in the tropics, and appears to enjoy a perpetual summer. During a calm night the noise can be heard at a distance of 15 miles. At 4 miles the sound resembles that of a railroad train crossing a bridge near at hand, and finally, as the escape orifice itself is reached, the roar is like that of a thousand locomotives blowing off steam together. At a distance of an eighth of a mile the sound is like a cannonade. The human voice is hardly able to make itself heard, and the flame seems to leap in the air at times to a height of 70 feet, resembling a burning steeple. In winter even, when the hills are covered with snow, for fully ten acres about the flame the grass is green and flourishing.

Composition and pressure of the gas.—These have been carefully examined by O. Wath. The gas is almost entirely composed of hydrocarbon of the formula $C^4 H^8$, mixed with a small quantity of carbonic oxide and carbonic acid. Its illuminating power is 7½ candles, that of coal gas being nearly 16. Its calorific power is with equal weights about 25 per cent greater than that of good bituminous coal. At the well, in a tube of 5⅛ inches, the pressure is about 100 pounds per square inch. In a smaller tube it exceeds 200 pounds, and in a tube of 2 inches, in which the gas is led to Freeport, 15 miles from the well, the pressure is reduced to 125 pounds. From this it may be concluded that by using a 5⅛ tube at a starting pressure of 100 pounds, the gas might be carried over a distance of 35 miles to Pittsburg, and there yield a pressure of 50 pounds to the square inch.

The ascending velocity is in round numbers 1700 feet per second, and if this be multiplied by the area of the tube, 17 square inches, a yield of 289 cubic feet per second, 17,340 cubic feet per minute, or about one million cubic feet per hour, is determined. The quantity of gas daily furnished is thus 1408 tons. Taking into consideration that for the use of furnaces the combustion of the gas is much more complete than that of bituminous coal, and that the effective heat produced is 25 per cent greater, supposing complete combustion in both cases, it is certain that the above figures are much below reality. The yield of the well in combustible material is estimated at more than 6.6 million pounds daily. The Burns well produces about one third as much.

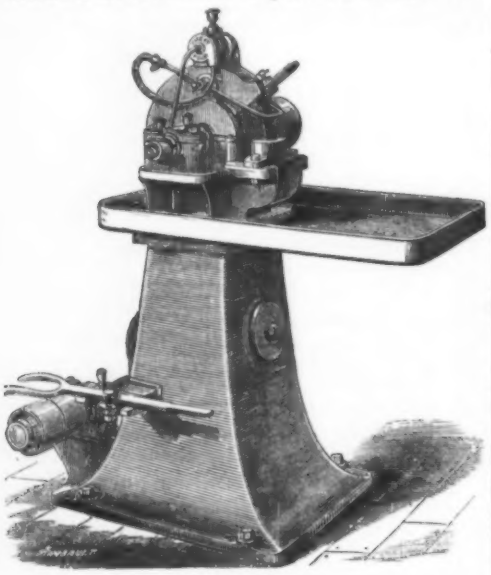
Duration of the gas wells.—All that can be said on this subject is, that in the region of upper oil, wells have furnished gas for 12 years without apparent diminution. One well at Fairview has fed with fuel more than one hundred engines for five years, and its production is the same now as during the first day.

Economical application of the gas.—The art of utilizing this immense quantity of combustible is still in its infancy. The gas from the two best known wells is only employed for the usages above mentioned. At Pittsburg, two iron foundries take gas from the Harvey well, 15 miles distant. This is the largest application at the present day. This last mentioned well is carried into the second stratum to a depth of 1200 feet; its diameter is 5⅛ inches. The tube in which it passes to Pittsburg is 6 inches in diameter, but the metal is very thin, and there is great leakage at the joints, so that the pressure at the end is much reduced. In the works the gas is used for iron puddling, and is stated to injure the furnaces less than coal, and to produce an economy of four hours per charge. A company has been formed to sink wells in Pittsburg, on the north side of the Monongahela. A second concern will carry on like operations on the south side. A third company, with a capital of $500,000, proposes to carry the gas from the Burns and Delamater wells into the city.

TOOL GRINDER.

We annex an engraving of an exceedingly neat arrangement of emery grinder specially intended for sharpening tools and doing similar work, constructed by Messrs. Thomson, Sterne & Co., of London and Glasgow. The machine we illustrate is provided with an emery wheel 14 in. in diameter by two inches broad, the spindle of this wheel being mounted in bearings at the top of a neat hollow pedestal, which also forms a water-tank. At the back of the standard are the bearings for the countershaft, this shaft being provided with fast and loose pulleys, so that the whole machine is complete in itself ready for fixing. The fast and loose pulleys are at one end of the countershaft, while at the other is a pulley from which the belt is led off to drive the emery-wheel.

The emery-wheel is provided with a cast-iron hood fitted at the front with a slide which can be adjusted so as just to touch the wheel. On the top of the hood is a small centrifugal pump, which lifts the water from the hollow standard, and delivers it through an india-rubber connecting tube to an iron pipe arranged as shown in the engraving, this pipe being perforated so as to discharge the water on the edge and against the sides of the wheel. The pipe can be adjusted to suit the reduced diameter of the wheel as the latter wears, and the quantity of water supplied is regulated by a cock. The centrifugal pump is driven by a small belt from the emery-wheel spindle, and its suction pipe is fitted with a foot valve, so that the pump remains charged when the machine is stopped. Any excess of water is caught by the tray and returned to the water tank in the pedestal of the machine.



TOOL GRINDER.

The wheel is driven so that its upper part turns towards the operator, and any tool being ground can thus be supported steadily on the rest provided at the front of the wheel. The latter grinds as well at its sides as on its edge, and any form of tool can thus be ground. The edge which the wheel imparts to tools is admirable, and from what we have seen of the operation of the machine we regard it as far preferable to ordinary grindstones for tool sharpening, even when these grindstones are in good condition. The machine, moreover, occupies much less space than a grindstone, and can be readily stopped and started, so that there is no occasion to run it except when actually in use. The renewal of a wheel when worn out, also, is a much easier matter than the renewal of a grindstone, and this is particularly the case with machines sent abroad, where the cost of transport of grindstones is no small item.

The use of emery-wheels with water is a practice which is, we think, likely to become considerable for other purposes besides tool grinding. The employment of water in connection with emery-wheels prevents grit, etc., from being thrown off, and seems to us to possess several advantages. It may of course be urged that the use of water on emery-wheels will tend to cause the rusting of the work ground, but we do not think any importance need be attached to this objection, for if the grinding is performed by grindstones it is done wet, while soap and water is continually used in connection with lathes and other machine tools turning out finished work. Of course if emery-wheels are used wet special arrangements must be made for supplying the water, as from the high speed at which the wheels run the water will be thrown off very rapidly. In the machine we now illustrate the water supply is capitally managed, the small jets striking the water supply is capitally managed, the small jets striking the surface of the wheel just in advance of the point at which the tool to be ground is applied. In carrying out the system in connection with wheels employed in other classes of work a similar principle would have to be adopted, while an adjustable hood should be provided to shield the operator from water thrown off from the parts of the wheel which are not in use.—*Engineering.*

TWIN STAIRS, ELEVATOR, AND LIGHT-SHAFTS.

By SAMUEL GRAY, San Francisco, Cal.

THE stairs are made self-supporting, requiring no walls, partitions, or iron columns to secure sufficient stiffness and strength. I construct the risers to extend to the bottom of the stringers at each end, and down to the ceiling, where they are attached at the bottom edge; the risers are attached to the front of the steps, to the back edge of the next lower step, and at each end of the same to the stringer, as well as at the bottom. The inside line of the stringers being of steeper ascent than the outside stringer, and being of the same width, a perpendicular line across the same is longer; hence the inside of the attachment of the riser is broader than that to the outside stringer, giving the effect of a bracket, and giving superior strength to the structure of the stairs.

It will be seen that the space occupied by the twin stairs is no more than that required for a single flight of spiral stairs, and a great advantage is secured in avoiding the obstruction caused by having to ascend and descend upon the same flight of stairs. The elevator is operated by four perpendicular screws, which operate in the platform or frame which supports the same.

The following is the operation of the same: The driving-shaft I being revolved by a small engine or other suitable motive power, motion is given to the screws F by means of

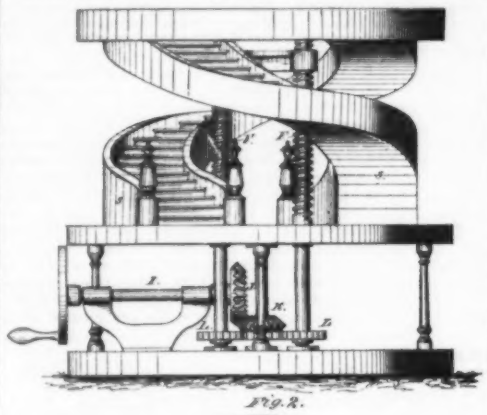
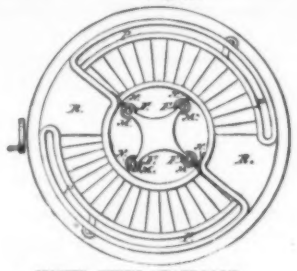


Fig. 2.



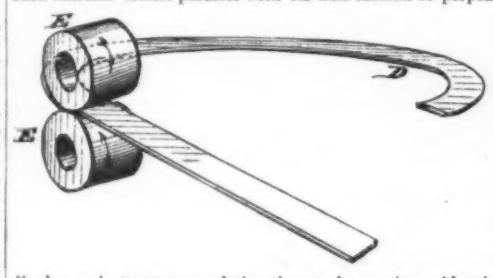
NOVEL TWIN STAIRCASE.

the bevel gear J and K and the spur gear L. The guard-sleeves M have mortises, through which the hangers N project, which hold the journals O of the screws F, and have an inner slot running the whole length, to allow the connection with the elevator and the same to move up and down. The light and ventilating shaft P is constructed by throwing an extra cylinder around and concentric with the stair-cylinder, with space between to admit sufficient light, and for ventilation. The light-shaft extends around the well-hole, except at the landings R, where the elevator-car is entered at each floor.

MANUFACTURE OF METAL RINGS.

By ALVIN TAPLIN, Bristol, Conn

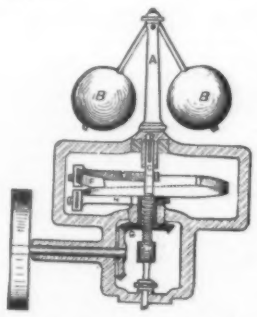
CONSISTS in making rings for supporting lamp-shades, and other like hollow metal rings, from a strip of sheet metal, which is first brought into the form of a flat ring as distinguished from a hoop, or, in other words, with the edges of such annular article parallel with its axis instead of perpendicular or in transverse relation thereto, by passing said strip between tapering rolls E E, arranged to give it a flat, circular, or helical configuration, and afterward subjecting the flat ring thus produced to pressure in a die or dies of the desired form.



IMPROVED GOVERNOR.

By W. D. MARKS.

THE pendulum spindle is in two sections, of which the lower one, to which, by means of a feather and key way, the driving power is geared, is capable of sliding lengthwise a little, at the same time that it turns the upper one, and screw up and down in the hub of its driving wheel; and is connected to the wheel by a spring which allows the wheel to over-run the spindle a little, when the motion increases to close the valve, in advance of any change of speed in the pendulum; and when the speed of the engine slacks, the tension of the spring will make the spindle over-run the wheel, which will screw the spindle along the other way, and thus open the valve in advance of any change of speed in the pendulum; thus making a much more sensitive governor than others now in use.



The sensitiveness of this governor is determined by the flexibility of the spring used; the more flexible the spring, the more sensitive the governor to any variations of speed in the engine. The power to move the valve with evenness is derived from the screw, the pitch of which determines its power.

The spiral spring may have more than one coil, as shown in the drawing, which, while giving more sensitiveness to the governor, also gives greater power, because of permitting greater angular separation of the ends of the spring, and also admits of a less pitch to the screw, and consequently greater power to move the valve, when the distance through which it is to be moved is the same.

The figure shown is a partial sectional elevation; A is the upper section of the spindle carrying the free conical pendulum B; C is the lower section to which the power through the spring F is connected. It enters a socket D in the upper section, and is capable of sliding lengthwise therein a little. It also carries an arm E, to the outer end of which is attached the upper end of the coiled spring F; whose other end is connected to the hub of the driving wheel G, by the arm H; to allow the driving wheel to advance faster than the spindle for a short time, when the speed suddenly increases; and fall behind it when the speed slackens, in order to screw the spindle up or down by its threaded portion I, in the screw-threaded hub of the driving wheel, and thus shift the valve up or down.

The power of this governor is only limited by the strength of the working parts, ball-rods, spring, etc. Should the spring break under any unexpected strain, the immediate closing of the steam valve will result, as the screw-threaded spindle will be at once screwed down to its fullest extent.

That this governor should have so great power is not surprising when it is seen that the inertia of the balls is used as a *point d'appui*, from which the valve is worked, and that instead of making use of centrifugal force only, as hitherto, the whole inertia of the free conical pendulum is used. For the sake of clearness, it must be especially noted that the balls B B are connected only to the central spindle A by a pin at the top, and that their centrifugal force is not made use of in this governor.—*Jour. Franklin Inst.*

A CLOCK WITHOUT HANDS.

THE above is an illustration of a new clock by Messrs Gillett & Bland, of Croydon, Eng. The most prominent advantage of this clock consists in the accuracy by which the time may be read off at a glance, and, it may be added, to a second There is none of the confusion with hands, and it is possible by cutting out the figures and illuminating the back, to procure a much more distinct illuminated dial than is obtainable by any other means. The clock may be described as on the simple principle of a counting or registering apparatus, actuated by clockwork, and indicating in large legible figures the exact hour and minute throughout the twelve hours respectively of day and night, from 0 h. 0 m. and 0 h. 1 m. etc., up to 11 h. 59 m., etc., so that even "those who run may read." A series of equal-sized wheels is ranged side by side, and exposing to view, through a slit or opening in the case, broad rims, on which appropriate numbers are marked; on the right hand is a small circular dial, with a hand performing one revolution each minute, which hand is moved by a pinion and contrite wheel attached to the third wheel of the clock train. Immediately this hand has travelled round to the top of the dial, indicating 60 seconds, simultaneously therewith the adjoining or minute wheel is engaged and carried round one tenth of a whole revolution. When this minute wheel has completed one revolution (corresponding to 10 minutes) it engages in the adjoining wheel to the left (which may be called the 10-minute wheel) and shifts it round through one twelfth of a revolution. Finally, when the 10-minute wheel has completed half a revolution, or one hour, it engages in the hour wheel, causing it to move through one twelfth of its revolution, and at the end of the full revolution of the hour wheel the set of wheels have returned to their original position, indicating 0 h. 0 m, or 12 o'clock. This method of indicating the march of *tempus edax rerum* possesses for certain purposes many and obvious advantages over the ordinary dial, for railway stations and public clocks in particular. Children and uneducated persons, generally more familiar with plain figures than with the (to them) mysterious dial, would be enabled to see the correct time at a glance. Moreover, time thus recorded must be legible at far greater distances, as individual clocks can obviously be made larger than is possible proportionately with a clock face, and the difficulty of distinguishing the hour and minute hands disappears. For clocks at harbors, seaports, lighthouses, landmarks, etc., to indicate the correct time—which is or may be longitude—to mariners, this principle appears to be highly useful.

A NEW MICROSCOPICAL DRAWING APPARATUS.

By Dr. HOLLE, Göttingen.

THE principle of this is to bring into view not the pencil itself or its reflected image, but the entire image thrown by lenses. The eyepiece of the microscope serves also as eyepiece of a telescope bent twice at right angles and having two mirrors. The first (transparent) is immediately under the eyepiece, the second, under the object-glass of the telescope. The former is very thin (0.2 mm.) that the images of the drawing-pencil, cast by the upper and under sides of the glass plate, may fall on each other. The other mirror is thicker; and between the two is a lens which again reverses the reversed image of the pencil. The microscopic image can thus be seen directly and without fatigue of the eyes. The drawing hand is immediately to the right, and so in the most convenient position. The image is unreversed.

ECONOMY OF ELECTRICITY.

AT a recent meeting of the Manchester Scientific Students' Association Mr. J. Faulkner delivered a lecture on the "Economy of Electricity," illustrated by a number of very beautiful diagrams and experiments. He said that some twelve months ago his attention was drawn to a phenomena that had troubled him very much, and that was that the apparatus he had made in certain circumstances did not always give him the same results, and having found that, he was "bothered"—to use a Lancashire phrase—he observed more carefully, and at last it brought him to a class of phenomena that startled him to such a degree that he was unable to sleep for weeks until he had unravelled the matter. That matter was what he had called the Altandæ system, or the system of raising. He illustrated this system by placing a bar of iron possessing no magnetism in a bobbin filled with wire. Immediately upon his sending an electric current round the wire magnetism was set up. He encircled the electro-magnet with a piece of common sheet-iron, and by that means the coil adhered and was lifted, the power being raised from about three to seventy. On encircling the electro-magnet with a larger covering the power was raised to three hundred. This was done with the same battery and the same coil, without altering any of the conditions, but he had surrounded it with iron. Continuing, Mr. Faulkner said that having got this great power, the next inquiry was, how does it happen that by simply surrounding it with iron, which possessed no magnetism, the power of the magnet was so much exhausted? Mr. Faulkner proceeded to answer this question by sprinkling some iron filings upon a paper placed over the magnet, by the attraction of which the iron was gathered into the centre of the paper in exactly the same shape as the metal below, but a portion of the iron scattered over the face of the paper, showed that there was still a waste of power. The magnet was then placed successively in a number of tubes, each of which decreased the quantity of waste, until at length the whole of the iron was collected in the centre of the paper and there no longer remained any waste. He also exhibited a number of diagrams showing the peculiar rays formed by the waste power and its gradual attraction to the centre. He had, he said, determined to try the result of raising the residuum of magnetism that remained in the magnet; that was, when you took hold of a piece of iron, according to its quality, it would retain or give up its magnetism. By that means they were enabled to tell whether iron was good or imperfect or mixed. He performed the experiment of raising the residuum by simply surrounding the magnet with sheet-iron, showing that he could economize not only the great qualities of magnetism and electricity, but could also economize the most feeble qualities. Not being content, however, he determined to try the experiment without the magnet which had been magnetized; he therefore took a bar of iron which had never had magnetism in it, and placed it in such a position that it would take up only from the earth that magnetism it is proper to give, and he produced the results seen in the three diagrams he exhibited simply by the earth's magnetism. He exhibited a number of diagrams showing the action of waste, including one on two sides of which the waste was economized while it was bursting from the ends, and from this, said the lecturer, I anticipate perhaps some of the greatest results that would arise from this Altandæ system. They had there a very ready method of placing their power wherever it was required. Having got the power the first object was to apply it, and the first object to which he applied it was the common electric bell, and the result had been that he had been able to revolutionize the form of the common electric bell. Again, he made use of it as an indicator, and utilized it for cotton factories for stopping the machines when the threads got broken, thus preventing an imperfect manufacture. Next for electric sounders. The telegraph operators on the Morse instrument could sit with their back to the instrument and write down what it said. Here, said Mr. Faulkner, showing a telegraph sounder, I have a movable cylinder, and by means of a screw I can either increase or decrease the quantity of covering, and thus regulate the power. By his system he gathered together the waste forces.

ELECTRO-MOTIVE CHANGES PRODUCED BY LIGHT.

PROFESSOR DEWAR, of Cambridge, gave the "Friday evening discourse" at the Royal Institution, his subject being the "Physiological Action of Light." He first referred to the experiments of Du Bois-Reymond, who found that strong muscular movements of the arm and leg produced changes in electrical condition which could be easily detected by a galvanometer. We have now the Sir W. Thomson's reflecting galvanometer, a much more delicate instrument, and it occurred to Professor Dewar that it might be possible to detect much more delicate changes than Du Bois-Reymond could. He showed, by having two troughs connected with the galvanometer and containing saline solution, that putting one hand in each, the mere muscular effort of shutting one produced a difference in the amount of the electric current. Other experiments also showed how readily the slightest change of electro-motive force could be in this way detected. It had occurred to him that the test might be applied to the excitation of the external organs of sense, especially with regard to the eye. Professor Dewar then proceeded to explain the way in which experiments on eyes of different animals were effected. The eye, on being removed from a recently killed animal (in this lecture frogs were used) is placed between two little supports which are called electrodes, and are thus constructed: there are two little troughs, made of zinc, mounted on vulcanite plates and carefully amalgamated. A small glass tube, drawn out to a point, is nearly filled with fine clay, and this is placed on the trough, the sulphate of zinc coming some little distance up the tubes. The ends of the tubes present only minute clay points. The object of this is to protect the animal structures from the irritant action of the solution of sulphate of zinc. These electrodes may be regarded simply as an arrangement for collecting and conducting off electrical currents from the structures under examination. Wires are connected from the troughs with the galvanometer, arranged so that the current can be cut off or put on at any moment. This arrangement is now found applicable for the examination of the eyes of living animals as well as of those recently killed. In the case of animals just killed, the recently removed eye is skilfully placed between the two clay points of the electrodes, and then the moment the connection is made with the galvanometer the mirror on the needle is seen to swing round, indicating the presence of an electric current. In a short time its reflection will settle down at some fixed point on the scale, and the amount of deflection will indicate the natural electric current passing from the corner to the transverse section of the nerve. Since almost every variety of living animal tissue shows an electrical current when examined in this way, it became an important question to see how much of the action here was due to light. To test this it is easy to put the eyes with the electrodes under a dark box with slide shutter. This was done, and time was allowed for the oscillating reflection on the mirror to settle, indicating the natural electric current which kept the needle of the galvanometer at a fixed position. Light was then allowed to fall on the eye, and at once a movement along the serum of the reflection of the galvanometer needle indicated a change in the electric condition of the eye produced by the light. The next consideration is whether this action occurs in any particular part of the eye. To test this the front part of the eye is cut away and one of the clay points brought in contact with the retina. This is an important point, because the change produced by the action of light might be supposed to be due to the contraction of the iris, the iris being a muscular structure contracting on the action of light by a well-known reflex mechanism in normal circumstances, and even after the removal of the eye from the head. A contraction of the iris might produce a negative variation of the electric current. This is why it is removed. The action observed accorded with that of the complete eye. The current is affected when light shines on the retina. Still further experiment, that of picking out the retina and leaving only the sclerotic, showed that while a current was obtained, it was not affected by light. Therefore it seems certain that the variation produced by the action of light is due to some chang which light effects in the retina. The experiments so far mentioned were, of course, made on eyes taken from recently killed animals, and up till lately there have been difficulties in experimenting in warm-blooded animals, owing to the rate at which the eye dies after removal from the body. Professor Dewar has, however, found that by placing an animal in such a position that some saline solution can be retained on its eye, and placing on this solution one of the electrodes, with the other electrode on another part of the body, successful experiments can be made. He has had the experiments tried on himself, so that there can, he explained, be no severe charge of cruelty to animals in experimenting on living rabbits, cats, lobsters, etc., as he has. The general conclusions arrived at are in accordance with those made on eyes recently removed from dead animals. Considerable difference is noticed whether the light brought near the eye is fixed or moved about. A light was arranged to oscillate by suspension, and the amount of deflection produced on the scale is far in excess of that when fixed. Due care was taken, as far as possible, to ascertain that heat had nothing to do with this action. Professor Dewar then went on to speak of experiments on the time occupied in a nervous sensation. The instrument used was the chronograph of Regnault, made by Kœnig, of Paris. It consists of a large tuning-fork, giving 200 vibrations a second. This is placed in an upright position, and is kept in constant vibration by an electro-magnetic apparatus. A stilette is placed on one of the arms of the tuning-fork, and in front of this is a strip of blackened paper, pulled down gradually by pulley, and arranged so that the stilette can mark on it. Each oscillation of the fork indicates the $\frac{1}{200}$ part of a second. Then on each side of this vertical tuning-fork, and on a level with the stilette, is another electrical apparatus, consisting of an electro-magnet, the prolonged armature of which carries a marker. As a current passes, the marker descends, making a mark on the blackened paper. It is arranged so that one of these markers signals on the paper the moment the light is put on; the other, under the control of an observer, signals directly the reflection of the galvanometer is seen to move. The position of these marks, with reference to the vibrations traced by the fork on the paper (200 hundred a second), gives the interval of time. It was found that with a frog's eye it was $\frac{1}{200}$, or $\frac{1}{4}$ of a second. This, however, includes also the time the observer took to see the phenomenon and record it, so that the real time elapsing between the admission of light and the change in electric condition is less than that. Other experiments show that there is an alteration in the electro-motive force by continued action of light, and this is, no doubt, the physical representation of what, in physiological language, is called fatigue. A number of tables showing the rate of fatigue were exhibited.

MAGNETO-ELECTRICITY FOR TELEGRAPHY.

MAGNETO-ELECTRICITY has not, until within the last year or two, assumed much importance in connection with commercial telegraphy. It is true that experiments have been made from time to time since 1845, to adapt the magneto-electric current to telegraphic purposes, but until a recent period these have not met with much success. There is now, however, a prospect that these efforts are to be crowned with success, and this result will have an important influence upon the future development and progress of the telegraphic art and business.

The magneto-current has for some time been successfully applied to electro-metallurgy, and is now extensively used for that purpose. That it will eventually wholly supersede the troublesome and expensive batteries which have been used in that art, we regard as certain. The improvements which have been made in magneto-electric apparatus have greatly increased its adaptability for this business, and the results obtained in its use have been most satisfactory.

Mr. Moses G. Farmer, who has justly acquired a reputation second to no other person in this country or Europe as a scientific and practical electrician, has been for years engaged in the study of this branch of electrical science, and has invented magneto-electric apparatus which has proved in actual service far superior to that of any hitherto known. By the use of the Farmer inventions the manufacture of the Compound Telegraph Wire has been entirely revolutionized, and an article produced which obviates the objections to that form of wire that have heretofore prevented its general introduction and use. The advantages which the compound wire possesses in its superior conductivity and comparative light weight would probably ere this have led to its general adoption for telegraphic purposes, but for the fact that the copper covering to the steel core, unless the wire was very carefully handled, was liable to become detached in places, thus impairing its conductivity and strength, and causing its destruction through chemical action and relatively high cost. These have discouraged the use of the wire and retarded its introduction in the telegraph service. The wire, as now made at the extensive works of Messrs. Wallace & Son, at Ansonia, Conn., is entirely freed from the objections heretofore urged against it. Immense vats have been constructed in which the coils of steel wire are placed, and the copper covering is deposited upon it to any desired thickness. Thus the copper and the steel become homogeneously combined, and can not be separated in handling or through accident, as has heretofore been the case. Magneto-electric apparatus invented by Mr. Farmer, and manufactured under his direction, is used to deposit the copper on the wire, which is done very evenly and rapidly. We propose, at some future time, to give a detailed description of the apparatus used and the arrangements for the manufacture of the compound wire, at Ansonia, which will, we think, interest our telegraphic readers.

Another, and by no means the least advantage of this new process for the manufacture of compound wire, is that it can be made and sold much more cheaply than by the former process. In fact, it can now be supplied in quantities, at prices very nearly the same as for the best kind of iron wire of similar relative conductivity. Its weight per mile being so much less than that of iron wire, it is of course more easily and economically transported and handled, and requires a smaller number of poles and insulators, so that telegraph lines can actually be constructed of this wire at a less cost than with ordinary iron wire, and the percentage of deterioration will be less. It would seem that with such advantages compound wire must eventually practically supersede iron wire for telegraphic purposes, and this has only been rendered possible through the inventions of Mr. Farmer.

The inventor and Messrs. Wallace & Sons have been engaged a year and a half, and a large amount of capital has been invested in perfecting the apparatus, etc., for the manufacture of the wire, which are now complete and in operation, and can be increased to any extent required to supply the demand.

Mr. L. L. Smith, the superintendent for Messrs. Wallace & Sons, of the manufacture of compound wire, has an electro-plating establishment at No. 6 Howard street, in this city, where several of the smaller Farmer magneto machines are in constant use. The process is similar, though on a smaller scale, to that used in plating the wire.

Much time and money has been spent in efforts to adapt the magneto-electric current to the operation of commercial telegraph lines, but heretofore none of them have been successful. Mr. Farmer has devoted years of study and research to this purpose, and has devised a magneto machine which is believed to have overcome all the difficulties encountered in working the ordinary telegraph apparatus with the magneto-current. Obviously, success in this direction could only be reached through close and protracted study and patient investigation and experience. These Mr. Farmer has given to it, and there is good reason to believe that he has succeeded where so many others have failed. Many of those who have been endeavoring to practically solve this problem have had at best but a superficial knowledge of the subject, and their apparatus when subjected to the test of actual working, have failed. So many of them have been unsuccessfully tried by telegraph managers that they have become discouraged and incredulous. This increases the difficulty of introducing an invention of this character into use, but Mr. Farmer's great scientific reputation will, no doubt, secure for his invention a fair and satisfactory trial, and if successful, his genius and labor should be abundantly rewarded.

With a conductor of superior conductivity, and a battery ready at all times to furnish a current unfailing and comparatively inexpensive, with a material reduction in cost of maintenance of both line and battery, the conditions of telegraphic success would be greatly improved, and cheaper telegraphic service might be compatible with proper remuneration both of the employés and the capital invested.—*The Telegrapher.*

HISTORY OF MAGNETISM AND OF ELECTRO-MAGNETISM.

THE earliest references to the properties of the magnet occur in the annals of the Chinese nation, who used it as a means of guiding the wayfarer over the vast and trackless plains of Eastern Asia, long before it was applied to maritime purposes. To the Emperor Hoang-Ti, who lived 2000 years before our era, is attributed the invention of a chariot upon which stood an elevated figure pointing to the South, independently of any position of the chariot. Nearly ten centuries later, we find the learned Tchéou-Koung presenting and teaching the use of tchi-nânkiu, or chariot indicating the south, to some envoys from Youá-tchâng, a southern maritime province. The compass, or, as it is even now called in Chinese, *tchi-nân*, appears to have been first used at sea by this remarkable nation about the third century of our era, during the Tsin dynasty.

When the compass became known in Europe is disputed; Gilbert refers its introduction to Marco Polo about 1260, but it is probable that earlier accounts of it were brought from the East by the Crusaders, an accurate description of it occurring in a poem entitled "La Bible," written by the minstrel Guiot de Provence, about the year 1190. A Latin letter, ascribed to Peter Adsiger, 1269, preserved among the manuscripts of the University of Leyden, contains the following remarks on the declination of the needle: "Take notice that the magnet, as well as the needle that has been touched by it, does not point exactly to the poles, but that part of it which is reckoned to point to the south declines a little to the west, and that part which looks toward the north inclines as much to the east. The exact quantity of this declination I have found, after numerous experiments, to be five degrees."

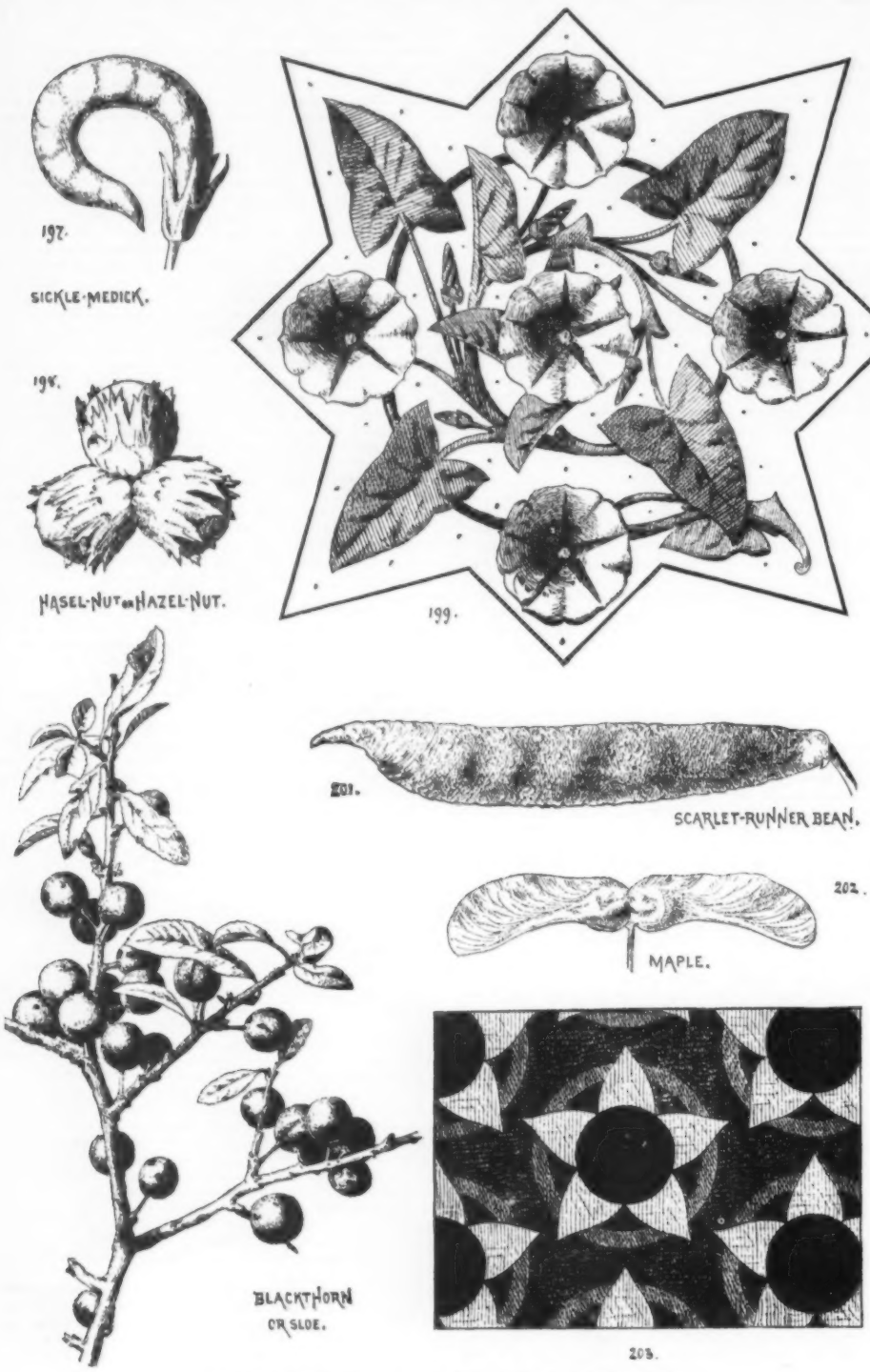
The discovery of the dip of the needle is due to Robert Norman, a nautical instrument maker at Wapping, near London, who is described by Gilbert as "a skilful sailor and ingenious artificer." He found that, after being touched by a magnet, the needle always appeared heavier at its northern end; and making an instrument to determine the greatest angle formed with the horizon, he observed the inclination in 1576 to be 71° 50′.

In the early part of the following century the variation of the declination was clearly ascertained, and was attributed by Bond, a teacher of navigation in London, to the motion of two magnetic poles.

In the year 1600 was published the celebrated treatise "De Magnete," by Gilbert of Colchester, who was pronounced by his great contemporary, Galileo, to be "great to a degree that might be envied."

CONSTITUTION OF THE SUN.

M G. PLANTE concludes from his experiments that the sun may be considered as a hollow electrified globe, full of gases and vapors, and covered with a liquid covering of molten incandescent matter; the wrinkles, or luculi of his surface, result from undulation in this liquefied stratum; the spots are produced by masses of gas and electrified vapors proceeding from the interior of the orb, penetrating the liquid layer, and giving to the edges of the cavities forms which characterize the passage of positive electricity. The *Faculæ* seem to be a brilliant phase in the evolution of the gaseous masses when they approach the surface before their eruption. The protuberances are formed by the gases themselves issuing from the interior of the sun at a higher temperature, and consequently more luminous than those which form the atmosphere of his surface.



SUGGESTIONS IN FLORAL DESIGN.

SUGGESTIONS IN FLORAL DESIGN.

THE graceful little corn convolvulus supplies the subject for the design marked Fig. 199. The forms of both flowers and leaves are direct transcripts from nature—the spiral line of the stem, the rigidly geometric character of the enclosing line of the panel, and the cruciform arrangement of the blossoms giving the needful adaptation to decorative purposes. The corn convolvulus should be sought for in the localities its name suggests, just about the time the corn is beginning to yellow, as it is then in perfection, and large masses of the plant will be found matting the ground and ascending the stalks of the grain. It should, however, be looked for on a bright and sunny day, as a bank or field that in the sunlight will appear thickly strewn with its delicate pink and white blossoms may be searched for them in vain when the day is dull and the sky overcast. The remaining illustrations are devoted to various kinds of fruit forms: the quaint pod of the sickle-medick, a plant so called from the form of its seed vessel (Fig. 197); the cluster of nuts (Fig. 198); the rich mass of purple sloe-berries (Fig. 200); the bean of the scarlet runner (Fig. 201); and the winged fruit of the maple (Fig. 202); all possessing a character that makes them ornamentally valuable. The design suggested in Fig. 203 is based on the berries of the dwale or deadly nightshade. We have endeavored in it to give some idea of the contrast between the pale green calyx from which it rises and the deep and lurid purple of the berry itself, and by the general sombreness of tone to hint something of the poisonous nature of the plant. The names of plants will often be found on analysis to contain much that is interesting and significant. In the case of the nut we have, it will be noticed, given two renderings of its name—the second or commoner name, and the first the one that should really be adhered to. The plant being indigenous to Britain has a name that is really Anglo-Saxon—hæsel-knut—and its significance is equivalent to hatted-nut, a name by no means inappropriate. The meanings involved in the names of many of our common plants are often very interesting and well repay study, though the exigencies of the case forbid our doing more now than merely mentioning the fact.—F. EDWARD HULME, F.L.S., F.S.A., in the *Building News*.

IMITATION OF CHINESE AND JAPANESE BRONZES.

FOR a long time the *patina* given by the Chinese and Japanese to their bronzes has excited the admiration of Europe. The dead black especially, from which the delicate arabesques, inlaid in gold or silver, stand out, has always appeared remarkable; up to the present time, however, the method of its production has remained a secret. It is well known that in China and Japan, as there are no patent-laws, various processes remain the property of a few families, and are handed down from father to son without the secret ever being made public.

The perfection to which chemical analysis has been brought at the present day makes known the secrets of Eastern nations without any inducement to have resort to stratagem for unravelling them. M. Morin, to whom were entrusted some specimens of various bronzes, submitted them to analysis, the result of which led him to form the opinion that the *patina* of black bronzes forms part of the metal, and is not due to a varnish or a superficial sulphurization, but results from the use of a bronze of rather complex nature, in which are 80 per cent. of copper, 4 of tin, 10 of lead, 2 of zinc, and 4 of iron, gold, nickel, arsenic, and sulphur. Some of the bronzes analyzed show a proportion of lead varying from 10 to 20 per cent added at the expense of the copper, and a quantity of 7 per cent. of tin. Moulded in very thin plates, this bronze readily takes any form given to it, and is easily worked, the *patina* appearing of itself when the finished work of art is subjected, in a muffle-furnace, to the action of a very high temperature. Unfortunately, these bronzes are very brittle, as many *virtuosi* have discovered to their cost.

Chemical analysis is, however, of little use in this case, unless it leads to synthesis. Incited by the high prices realized by black bronzes, and desirous of turning to account the effects of contrast obtained by the silver or gold inlaid on a black ground, French manufacturers have made experiments on various processes for the manufacture of bronzes like those of the East. M. Morin, and MM. Christofle and Bouillet, have been more fortunate than those who preceded them, having arrived at an imitation of the Japanese bronzes, if indeed they have not surpassed them, for to beauty of appearance the metal unites a strength equal to that of ordinary bronze. Starting from the principle that to be lasting and uniform a *patina* should not be a simple varnish or the result of a laying on of color, but should constitute a chemical change of the surface of the bronze; in the second place rejecting as too fragile the lead bronzes of the Japanese, to adopt the copper bronze worked by the hammer, or deposited by electro-metallurgy, the manufacturers above mentioned have presented to the Académie des Sciences some specimens of their work. These objects had the black, brown, red, and also the green *patina*, perfectly uniform; some had more than one tint on their surface, and others were inlaid with gold or silver.

The processes adopted for obtaining the ground, consist of subjecting the objects to the action of chemical compounds, having the oxides and sulphides of copper as their base; and the principal condition of the intensity and uniformity of tint consists not only in the choice and the purity of the substances employed, but also in the length of time occupied by the process.

If different tints be desired on the same object, it is sufficient to cover with a protecting varnish all portions of the surface except those to which it may be desired to give a certain hue; then, when this has been treated for a sufficient time, it is in turn covered with varnish while the other portions of the surface, now exposed, are subjected to the action of the chemicals, and so on for as many tints as may be required.

The inlaid enamel work which is performed by Oriental artists with so much skill and patience, and at the same time with such primitive appliances, is now executed by simpler and quicker means. The object to be inlaid is entirely covered with varnish, portions of which are removed by a graver, so as to form the design; and thus prepared, it is subjected to the action of a galvanic bath of gold or silver, which deposits the metal in the places laid bare by the graver. Another method is, however, mentioned by M. Morin. After the removal of the varnish according to the pattern by the graver, the object is plunged into a solution of cyanide of silver. The salt is deposited on the lines from which the varnish has been removed; the object is heated in a muffle-furnace, and the metal appears on the black *patina*. Inlaid patterns of gold and silver may be obtained, either of their natural brightness, or with a dead surface, the latter being effected by different processes of oxidation; so that, on the same object, by making use of the protecting varnish, designs in gold and silver of various degrees of lustre may be combined.

FADING OF COLORS IN ZOOLOGICAL COLLECTIONS.

AT a recent meeting of the Entomological Society of Belgium, M. Capronnier read a paper giving an account of some experiments which he had made bearing on the question as to how public collections of insects may best be exhibited so as to satisfy all the purposes for which they are intended. M. Felix Plateau, at a former meeting, proposed to substitute yellow for colorless glass in lighting rooms containing entomological collections. In the discussion which followed, it was suggested that experiments should be made by submitting insects to the influence of glasses of various colors. M. Capronnier was entrusted with carrying out these experiments, and the paper referred to contains his report.

Every one knows that among the Lepidoptera it is the green and carmine colors which are most rapidly destroyed by daylight. M. Capronnier wished to obtain insects of the year's hatching, but could only obtain sufficient quantities of *Euchelia Jacobææ*, L. The inferior wings of this insect are of a deep carmine, uniform in tone, an important point in the experiments.

The principal colors of the solar spectrum are the yellow, the red, the blue. M. Capronnier rejected the red as giving a tint too dark, and added the mixed colors, violet and green. He had thus four tints chosen with the same degree of tone, and of a moderate shade—yellow, violet, green, and blue, besides a colorless glass. He made five small square boxes of .08 centimetres square and one centimetre in depth; the whole surface was covered with one of the above-mentioned glasses.

Each wing was fixed in the middle of the box and floated in a bath of very bright light, but protected from the rays of the sun. Each of the wings was partly covered by a band of black paper, and their position was so arranged as to leave exposed successively each of the parts during a period of fifteen, thirty, and ninety days. The following are the results:

Colorless Glass.—After fifteen days of exposure the carmine tint was visibly attacked. After thirty days the alteration was more sensible, and after ninety days the work of destruction had rapidly advanced, and the carmine had passed into a yellowish tint.

Blue.—With this tint the same alterations took place as in the case of colorless glass.

Green.—This color preserved the carmine during the first fifteen days; a change was indicated on the thirtieth day, and on the ninetieth the alteration was marked.

Yellow.—During the ninety days the yellow alone left the carmine color almost intact. M. Capronnier says *almost*, for a slight alteration in the tint could be noticed at the end of the ninety days. This last observation proves that there is no absolute preservative, and that collections must be kept in darkness, under penalty of seeing them seriously changed at the end of a given time.

Nevertheless, it is evident from the above that the yellow is the best preservative against alterations in the colors of insects. M. Capronnier consequently concludes that a yellowish color should be preferred and combined in every arrangement of an entomological room. Moreover the cloths that cover the show-cases ought to be yellow rather than green, and what is important and indispensable, the window-blinds ought to be absolutely yellow.

LUNAR GEOLOGY.

As the moon has no atmosphere, and as her surface is destitute of water, it might be assumed that lunar scenery would not offer evidence of denudation. Such an assumption is confirmed by Mellard Reade's study of the surface of our satellite. He concludes that the geology of the moon differs markedly from that of the earth, in that it is destitute of sedimentary rocks; that the surface of the moon presents no marks of denudation; that there never has been either an ocean or an atmosphere to the moon; that in the absence of steam there would be no volcanic ejecta; and that the rocks of the moon are not folded and contorted, like ours, but simply fissured by secular shrinkage.

LESSONS IN MECHANICAL DRAWING.

By PROF. MACCORD, Stevens Institute.

(Continued from page 412. See Illustrations on page 411.)

No. XIV.

WE have introduced the cast shadow on the left, more for the purpose of showing the full effect of the design than as exercises for practice. But if they be attempted, it may be worth while to state that the best effect will be produced by cross-hatching; that is, by drawing fine lines in all directions, horizontal, vertical, with both the 60° and the 45° triangles to right and left. These lines should be as fine as possible, allowed to dry before going over the surface in another direction, and drawn with thin ink, going over again and again till the desired tone is attained, the last lines being parallel to the shadow line, retouching where necessary with a fine-pointed steel writing pen. And they should not be made uniformly heavy, but darkest next to the outline of the body casting the shadow, and lighter near the edges; a shadow, in a drawing as in nature, should not terminate abruptly by a definite line, but rather fade away and disappear imperceptibly; in line work pure and simple it is not easy to avoid an unpleasant sharpness in terminating a shadow; still, with due care and patience a very good effect can be produced in the mode described.

Although this design is given as intended for architectural decoration, it may not be amiss to say for the benefit of any lady readers who may recognize it as very like the "Grecian border," familiar to them in ornamental fabrics, that there is not the slightest objection to their appropriating it for embroidery, nor yet to their varying the proportions of the fret-work, should those we have given be not satisfactory to their taste. In fact, while preserving the characteristic effect due to the peculiar convolution of the main outline, these elegant borders may be given a great variety of minor detail, especially in regard to proportions: they may be extended longitudinally or vertically, according to the circumstances of the case, so as to be in keeping with their surroundings or with what they surround, to be precise about it, without losing their individuality, and the designing of them may be found as pleasant and as profitable a recreation as their execution.

All that has gone before has related to the drawing of right lines or circular arcs. And it has been stated that in the drawing of machinery these elements are most extensively used; in fact, a plan to be worked from by a mechanic should, if possible, contain nothing else, because in that case we can lay out the lines on wood or metal with the tools which he is accustomed to use. But this is not always possible: there are cases, and they may be met with at any time, in which curves that are not circular must be introduced. Very frequently, it is true, we are able to compromise the matter by drawing an arc of a circle which very nearly agrees with a part of the curve, and when the deviation becomes perceptible, taking a new radius and a new centre, and drawing another arc, and so on, taking care that the arcs are tangent to each other where they join. This is a very common expedient, and it answers all practical purposes, since if the circular arc has so nearly the same curvature as a part of the correct line to be drawn that the eye can not detect the difference between them, it is evident that no appreciable error can result from the substitution of one for the other. But in order to do this it is necessary to draw the curve first: we must know what the form is for which the arcs are to supply the substitute. And it is advisable for the student to acquire some skill in the drawing of such curves, so that when he does meet with such things in practice he may not be at a loss to know what to do. We propose, therefore, to introduce from time to time some exercises of this kind, which will be not only a relief in the somewhat monotonous work of practising with right lines and circles alone, but beneficial in training both the eye and the hand. And we begin here with the ellipse, which is in the first place a beautiful curve intrinsically, and what is more important, the one which will be more frequently met with than any other: as will be seen when we come to *drawing* proper, as meaning the representation of solid objects, it is a very common case in the drawing of mechanical subjects that a cylinder is viewed obliquely, or is cut off at an angle, in which case the circular end or the section, as the case may be, is of an elliptical form, as seen in the drawing. Were we then to leave this sort of exercise until these cases actually arise in the regular progress of our studies, the reader would be under a very decided disadvantage, as having two new things to master at once; and he will find that the drawing of an ellipse is in itself a matter sufficient to engage his attention, and one, too, that will require some little practice to do it well and quickly.

There are several different methods of drawing the ellipse, each having its advantages under different circumstances. We give first one of these, which will convey to the reflecting reader, who may be unacquainted with the properties and distinctive features of the curve, an idea of some of the more prominent and useful ones, in what we think the readiest way, as well as the clearest. Let E and F, Fig. 129, be two pins fixed in the drawing-board, and let E P F be a string fastened to these pins at its ends, so that it may turn freely round on them. Let P be a pencil, placed in the bight of the cord, and moved away from the pins so as to pull it taut. If now the pencil be moved say to T, we see that because the string is of the same length all the time, E T + T F is equal to E P + P F: so also is E G + G F; and the same is true wherever we move the pencil. In other words, the pencil moves in a curve, which has this property that *the sum of the distances from any point in it, to two fixed points, is constant.* These two points, E and F, are called the *foci*: let us now draw a straight line through them, and prolong it ind finitely. Then studying a little further into what will happen, we shall see that as the string is longer than E F, the pencil may be moved to the left from P, till it reaches this line just drawn, at some point A, where A E + A F just makes up the length of the string, and clearly it can go no farther to the left. The pencil is here at its least distance from E, at its greatest distance from the other focus F, and the string is doubled from A to E. Clearly, also, there will be a corresponding point B at the right, where the pencil will be nearest to F, farthest from E, with the string doubled from B to F; and as the length of the string is not changed, and E F is the same always, we see that A E is equal to B F, and that A B, the greatest length of the curve, is equal to the length of the string. The points A and B are called the *vertices*, and A B is called the *major axis*. And since we can do below this line just what we have done above it, we see that the lower half of the curve will be precisely like the lower half. Again, it is evident that there must be a point G, where E G equals G F: drop a perpendicular G C from this point on A B, and it will be clear that it measures the greatest distance to which the pencil can go from the major axis, and also that it bisects it: there is of course a corresponding point D below the line, and we see that G D also divides the curve into two equal and similar parts. G D is therefore called the *minor axis*.

Now the pins and string are, for reasons which we shall afterward mention, not suitable for this purpose on the drawing-board; but from the above explanation we shall see that our instruments will enable us to construct the ellipse by points, as the expression is. That is to say, to find by means of intersecting lines a number of points through which the curve must pass. This phrase will be frequently used hereafter, and to prevent disappointment we warn the student not to form the false impression that it means to draw the line by continuous motion. There are instruments for thus drawing ellipses, which we may hereafter describe, but they are costly and inconvenient; and besides, there are many other curves which we shall have to deal with which can not be thus drawn, and practice on this one will come in play when we meet with those.

Suppose then that we wish to draw an ellipse of a given length, A B, and a given breadth D G, we first bisect A B at C by an indefinite perpendicular, on which we lay off C G and C D, each being half the minor axis: and as we have seen that G and D are each at a distance from either focus equal to half the major axis, we find E and F, by the intersections with A B, of an arc whose centre is G and radius A C. Or if the distance between the foci is known, and also the length of the ellipse, we find G and D, and thus determine the breadth, by the converse process; that is, describe about E and F, the foci, two arcs whose radius is A C, and they will intersect at G and D. If the minor axis and the distance between the foci are given, bisect E F at C, erect a perpendicular at that point, set off C G, half the minor axis, and E G will be equal to the half major axis A C.

Now having the foci, suppose an arc to be described about F, for instance, with any radius as F T, greater than B F, and

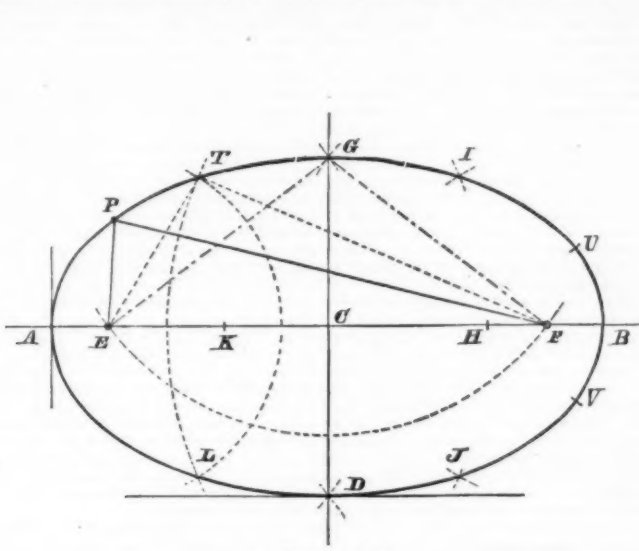


Fig. 129.

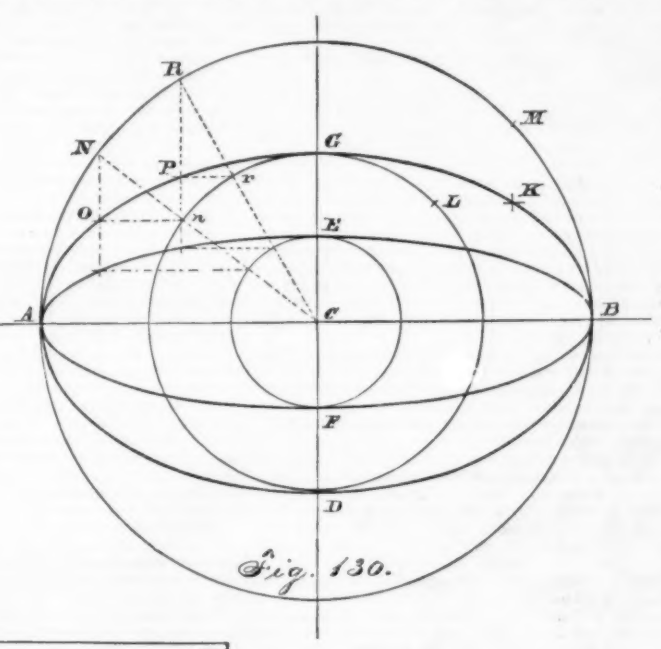


Fig. 130.

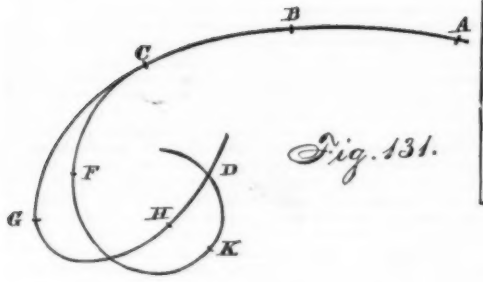


Fig. 131.

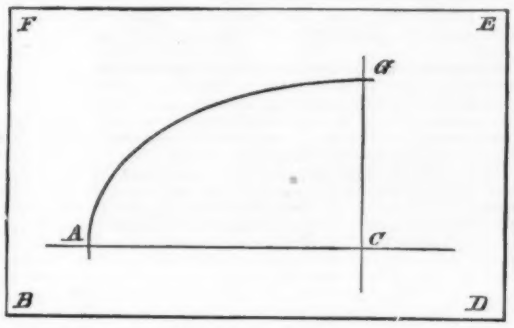


Fig. 132.

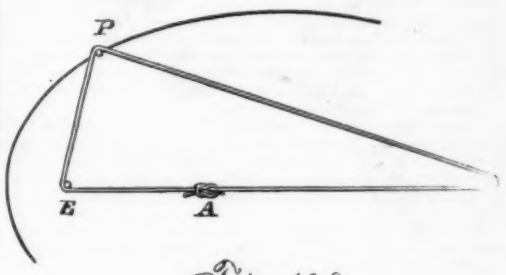


Fig. 133.

LESSONS IN MECHANICAL DRAWING.

less than A F; this arc must, evidently, cut the ellipse somewhere. And wherever that intersection is, we know that its distance from E added to F T must equal A B. Then we have only to subtract T F from A B, and with the remainder as a radius, describe another arc about the other focus E as a centre, which will cut the one first drawn in two points, which must lie on the required curve. This operation of subtraction is performed, not arithmetically, but with the compasses, thus: having drawn the arc with radius F T, set the instrument on the paper so that the pencil point is at B, the needle point at K on the major axis, then turn it half round and set the pencil point at A, thus adjusting it to the radius A K, which is evidently equal to A B − F T; in this way we find E T, the radius with which are made the intersections at T and L. And in a like manner we may determine as many points as we wish.

It is not necessary to draw the whole arc with either radius: we have done so on the left for the purpose of making the construction clear; but in practice all that is needed is a short bit of each arc, just enough to make sure of getting the intersection, which is the ultimate object; and the eye will quickly become able to judge of this within quite narrow limits. This is illustrated on the right, for obviously what we do around one focus we can also do round the other, and thus with each pair of radii we can determine four points in the ellipse. For example, after striking the arc T S about F, we strike another about E, before changing the radius (or rather the two short arcs, one above and the other below A B, as shown at I and J. Then subtracting T F from A B as above, we get the radius A K, with which we cut the other arcs at T and L, with centre E, and at I and J, with centre F.

Now the number of points to be determined in this way is entirely arbitrary; but there is one general principle which applies in the construction of any curve by points, of such importance that we introduce a separate diagram, Fig. 131, to illustrate it. Suppose A, B, C, and D, in this figure, to be

four points in a curve, determined by some given law, of such a nature that no waves or sinuosities exist, in that region at least. In regard to that part between A and C there will be very little room for doubt; but between C and D we have drawn two very different lines, either of which has a very plausible appearance, regarded as a continuation of the curve A B C; and it might puzzle not only a stranger, but an intimate acquaintance, to tell which of the two has the better claim to recognition, or indeed whether either has any, as it is clear that a great number of curves might be drawn through C and D, all of them tangent to A B C. Under these circumstances, we naturally resort to the expedient of finding by the given law of construction another point between C and D. Suppose in the case in question that E is this intermediate point, it is clear from the figure that the question is not yet settled, for E is common to the two curves in regard to which the question arises. But, repeating this operation, we determine a point between C and E, and another between E and D. This helps matters materially, for if these points last found fall at G and H respectively, it becomes certain that the curve C F E K D is a false claimant, and is to be thrown out of court accordingly. If, on the other hand, they fall at F and K, it is equally clear that the other curve C G E H D will not fill the bill.

Now, a little reflection on this will lead to the general principle above alluded to, which is, that the sharper the curve is the closer together must be the points by which it is determined. And being a general principle, it applies equally well to any part of any curve, and in constructing one by a given law, we may extend the enunciation just made by saying that the points must be closest together where the curvature changes most rapidly. Thus, returning to our ellipse in Fig. 129, it is clear that in order to insure equal accuracy in all parts, it will be necessary to find more points between P and A than between P and G.

So much for the method of construction: having found a sufficient number of points, the next thing is to draw the curve. In doing this, the student is recommended to sketch it in very lightly, free-hand. This trains both hand and eye; and, moreover, it affords a pretty good list of the accuracy of the construction. For it must be kept in mind that in the determination of points by intersections in this way there is always a possibility of making an error. And when we know, as we certainly may assume that we do know in this case, that the curve must be a smooth, or as it is technically called, a *fair* one, free from sinuosities or abrupt changes of curvature, it is too evident to need argument, that if a point which we have determined by the given law of construction be so situated that it would give the curve such a sinuosity, that point must be in the wrong place.

It is not always necessary, when we find this to be the case, to go to the trouble of making a new determination in order to find out just what mistake has been made; if other points in the immediate neighborhood mark out the path without ambiguity, we may safely follow their guidance, and leave the erroneous point to take care of itself.

In sketching in this ellipse, a good guide at critical points is to be found in the fact that it has a horizontal tangent at D, and a vertical one at A, as shown in the diagram; and the student should look carefully to see that the curvature from D to L, for example, is the same as that from D to J; and so in the region of A, and the other similarly situated points, G and B.

This freehand sketching is to be regarded merely as preliminary, and is to be done with the faintest line that is visible, the pencil should be held as far from the marking-point as possible, and the paper turned round so that the part of the curve in progress may be always concave toward the hand.

The line is then to be pencilled in more firmly, in which operation curved rulers, or sweeps, as they are called, are usually employed; but if they are not to be had, it will be found good practice to do it freehand, and the inking in may be advantageously done in the same way, with a steel writing-pen, *for the sake of the practice only*. For it is not possible in this way to make a line as firm, sharp, and uniform as with a drawing-pen and suitable sweeps.

But in either case it is admissible to make use of circular arcs for portions, if not the whole, of the ellipse; because, although this is not, theoretically, correct, yet it is clear from the figure that the changes in curvature are so gradual, that isolated parts of it can not be distinguished by the eye from parts of circles. And that is our practical limit of accuracy. If we use these arcs, instead of the actual curve, no one will see it unless he knows it, or know it unless he sees it. A perfectly proper proceeding, then, is to find, by trial and error, a centre H on the major axis, such that an arc struck around it through B will sensibly coincide with the curve for some distance above and below A B; then mark off equal distances B U and B V, the points U and V being a little nearer to B than the first sensible divergence of the circle from the ellipse: the same radius is, of course, to be used at the opposite vertex A, and the arc must be of the same length. A like proceeding will enable us to draw an arc, say from T to I, its centre being of course on the minor axis; drawing also L I, with the same radius, we have the four most critical parts of the ellipse drawn, thus leaving comparatively little to be filled in by hand or by the curved rulers, and making sure that the horizontal and vertical lines at the sides and ends shall be truly tangent to the outline, as above stated to be necessary. Just how necessary was not stated, except inferentially, as this is a property of the curve: we may now add that it is *imperatively* necessary—that is, that an error in this respect will be more conspicuous than almost any other fault that can be mentioned; in regard to which we shall have more to say hereafter. At present it will suffice to put the student on his guard.

We have pointed out the means of determining points all round the curve, and there is no harm in some practice in doing so. But we may remark that it is not at all necessary. We observe that the curve consists of four precisely equal and similar parts, or quadrants, and there are a needless amount of repetition is involved in constructing them all. And our object being to make the reader acquainted with all the tricks of the trade, we may explain here an expedient which comes as near to a labor-saving device as any within the reach of the draughtsman. We mean the operation of copying by transferring, which will be understood by the aid of Fig. 132, in which B E represents a piece of transparent paper—in a drawing-office tracing-paper would always be at hand, but the thin letter-paper used for foreign correspondence will be found just as good. Let us suppose, now, that we have constructed the quadrant A G of the ellipse in Fig. 129: we lay this bit of paper over it, and carefully trace its outline in pencil, and also the centre lines, A C and G C. The pencil used for this purpose should not be of the hardest, but it should be well trimmed, and the line drawn with the aid of the compasses, or sweeps, as carefully as if it were to be a complete copy. If we now turn the paper over, adjusting it carefully by means of the centre lines, the quadrant will be reversed in position, so as to coincide with G B of Fig. 129; and by going over the curve again, with a firm pressure, as though our object were merely to make a pencil copy, it will be found that a little of the black-lead of the first pencilling will have been transferred to the paper below, giving a faint trace of the second quadrant G B. At the same time, we shall have blackened the paper slip on the other side, so that by again turning it over, making A C coincide with B C of Fig 129, and G C with D C, we will be able to put in the quadrant B D; and in this way we see that it is only necessary to construct one quadrant of the ellipse.

This simple mode of proceeding will be found of great convenience in the drawing of many kinds of curves which are composed of similar and symmetrical branches, as well as in saving the labor of reconstruction when the same curve is to be repeated in different positions. We may remark that a process of similar nature is sometimes recommended—that is, having made a copy on thin paper in this way, the transfer is made by pricking holes at short intervals with a fine needle. We recommend the reader carefully to avoid this barbarous device, the transfer by pencil being not only more easily executed, but superior in every particular.

Another method of constructing the ellipse, and for the draughtman's purposes a better one, is given in Fig. 130. Let A B be the major axis, G D the minor, C the centre. Describe about C two circles, one having the diameter A B, the other the diameter G D. Draw any radius, as C N; it cuts the outer circle at N, the inner at *n*. From N drop a perpendicular to A B, and draw through *n* a parallel to A B; their intersection O will lie on the ellipse. In like manner, by means of the radius C R, and the parallel and perpendicular *r* P, R P, we find P, and by repeating the process we may find as many points as we please. Let it be observed that the position of the radius is immaterial, so that it is not necessary to divide the circle into equal parts, as some mistakenly apprehend. Wherever we want a point in the curve, we may find one—as, for instance, suppose we wished to locate one, say as far to the right as K: having the T square in position, we place the triangle so as to draw a perpendicular through K, mark the point M where it cuts the outer circle, set the triangle to draw a radius M C, which we do not draw, however, but simply mark the point L in which it cuts the inner circle. Then with the T square draw a short line at the region K—the eye can judge nearly enough where the perpendicular from M will fall, to make it unnecessary to draw the horizontal more than a quarter of an inch long; finally, with the triangle mark the required intersection, K. Thus, in practice, it is not necessary to draw even the radii, nor is it advisable, since it merely covers the paper with lines to be rubbed out afterward.

We have drawn two ellipses on the same major axis, A B, the narrower one having E F for its minor axis; this is for the purpose of calling attention to the circumstance that the ellipse, though always fulfilling the conditions of the fixed law stated in connection with Fig. 129, may have an infinite variety of actual forms, the proportions between its length and breadth varying so that the curve ranges from a circle on the one hand to a right line on the other. A drill in practising the drawing of ellipses as an exercise, the student is advised to vary these proportions as much as possible, inasmuch as the construction is the same in all; but the actual curvature of the line varies with every change in size or proportion, so that this variation will make the practice more beneficial than if he were to confine himself to drawing ellipses of the same size in different ways.

The second method here given is much more convenient on the drawing-board than the other, and, in fact, is one of the best known for general use, the intersections being well-defined, and the construction remarkably simple and expeditious.

The first one is objectionable on various grounds—the intersections are not always well marked, the arcs sometimes crossing each other very acutely, and the adjustment of the compasses to two radii for each makes the operation tedious. But it gives a better idea of the nature of the curve than any other, for which reason we explained it first.

In regard to drawing the ellipse by continuous motion, by actually using the pins and string, it is clear that the holes made in the paper by the former would be unsightly; there is also difficulty in adjusting the string to the precise length required, in order to give the ellipse accurately a stated length and breadth. But for many purposes this mode is very good—as, for example, in marking out an elliptical frame for a picture, or tracing the outline of a flower-bed in the garden or on the lawn. For these purposes, however, a modification, shown in Fig. 133, will be found more convenient. Here E and F are the foci, P is the tracing-point in the loop of the cord. The latter, however, is not fastened to the pins, but passes freely round them, forming an endless band, the ends being tied together at A. In this way the whole curve may be traced by one continuous motion of the marker P, care being taken to slip the cord round the latter and the pins in such a way that the knot may never come in contact with either. It is hardly necessary to observe that the cord must be one that will not stretch, if it be possible to find such, as any variation in its length will impair the accuracy of the curve. Its length, in this case, must be equal to the major axis plus the distance between the foci; but the identity of the operation with that first described is apparent from the fact that the portion between the pins, E and F, is constant, and constantly idle, the curvature being controlled by E P F, the bight of the cord.

(To be continued.)

IRON IN THE SPLEEN.

PICARD and MALASSEZ, starting from the fact that the proportion of iron in the spleen is greater than can be accounted for by the blood it contains, proceed to inquire whether this iron is present in the form of some special compound, or simply in that of hæmoglobin fixed in the splenic tissue (*Comptes Rendus*). The latter view was found to be the correct one. The following was the mode of investigation adopted: The gland was thoroughly washed out by allowing a stream of salt solution (shown by Kühne to be incapable of dissolving hæmoglobin) to flow through it until it escaped colorless from the splenic vein. Notwithstanding the complete removal of the blood, the organ still retained its deep-red color. A stream of distilled water was then admitted into the artery; it issued bright red from the vein. After about two litres had thus permeated the gland, the latter was found to have lost its red color, and no longer to tinge the water flowing through it. The coloring matter dissolved by the distilled water was proved by its behavior towards oxygen, carbonic oxide, and reducing agents, to be ordinary hæmoglobin. The decolorized spleen was then submitted to analysis, and found to be entirely free from iron. Hence the authors conclude that iron exists in the splenic tissue as a constituent of hæmoglobin, identical with that of the red corpuscles of the blood.—*Academy*.

TRANSFERRING, REVERSING, AND TRANSPORTING NEGATIVES.

WE have been shown by Mr. Walter Paul various results of a method of transferring a number of negative films to one plate. This forms a *multum in parvo* negative, and the method will prove exceedingly useful for many purposes. Previous to indicating these purposes, however, we shall give a description of the process itself.

The only appliances required not usually found in every studio, are a few sheets of plain gelatinized paper; that is to say, plain paper, which has been drawn over the surface of liquefied gelatine in a dish, and which has then been hung up to dry. For various purposes in photography the gelatine which is applied to the surface of paper is rendered insoluble by the admixture with it of chrome alum or by subsequent treatment either with tannin or alum; the paper required for *this* process is a simple gelatinized one, the condition of the gelatine not having to be altered in any way. Any paper will do, but fine Rive or Saxe paper is most to be recommended. The strength of the gelatine is one ounce to a pint of water.

A piece of the transfer-paper, having been previously wetted in cold water, is laid carefully down upon the collodionized surface of the negative, which must just previously have been also made wet with water. The paper is pressed in contact with the negative by means of a squeegee, and allowed to remain until perfectly dry. It is important to notice that the drying must be spontaneous, no heat being applied to aid the operation. When this has been effected, any trimming that may be deemed necessary can now be done, or, if preferred, this may be deferred until after the transference of the film.

To remove the film, all that is necessary is to sponge the back of the paper with cold water, taking care that every portion is moistened. After the lapse of one or two minutes the paper is lifted by one corner and peeled off the glass—an operation effected with surprising facility. The collodion film is now found attached to the paper, to which it adheres.

In this state it forms an excellent reversed paper negative, and, as the whole of the detail is imbedded in the collodion, no falling off of the sharpness can possibly take place. To expedite the printing the paper may now be rendered translucent by waxing, varnishing, or by the adoption of any of the means so well known for effecting such purpose.

The transferring of the film to a glass plate is effected in the following manner: The glass, having been previously coated with a solution of gelatine of about one ounce to sixty ounces of water, to which has been added a little chrome alum, and this substratum having been allowed to become dry, is placed in a vessel of water; when lifted out it is placed in a tolerably level position. The negative on its paper support is now made wet, and then carefully laid down upon the glass, care being taken that there are no air-bubbles allowed to remain between the collodion and the glass. The services of the squeegee are had recourse to again, and the whole allowed to become dry, which at this stage is by no means a tedious affair, about thirty to forty minutes being sufficient. It is then placed in *warm* water, by which the paper support is immediately brought away, leaving the collodion film securely attached to the glass plate.

The negative is now in an admirable condition for being worked upon by the retoucher, as sufficient of the gelatine still remains to give a fine tooth for the pencil, and to afford complete protection to the silver image. After this the negative is varnished in the ordinary way.

As one great use of this process is the placing of several subjects upon one plate of glass, it follows that judgment must be employed in the placing or "laying down" of each subject. In cases which involve a large number of prints of one subject, a number of negatives can be placed side by side, and at the requisite distance apart, so as to allow of easy trimming and the avoidance of any waste of paper in printing.

To produce a reversed negative on glass, it is requisite to apply a thin solution of india-rubber in benzole to the collodion side of the sheet of paper bearing the pellicular negative, and then to press this in contact with a second sheet of paper also coated with rubber solution—in fact, just mounting the picture face downwards, and by means of india-rubber paste, upon a sheet of paper. This compound sheet is now placed in warm water, when the gelatine paper immediately comes away, leaving the collodion attached to the sheet last applied by the india-rubber solution. The picture is then laid, again face downward, upon a clean plate of glass, pressed in intimate contact with it without any previous preparation being applied, and the whole allowed to remain till dry, when the paper may be stripped away, leaving a clean negative upon the glass. Should the india-rubber paste hold too tenaciously it may be prudent to sponge the back of the paper with benzole, by which its hold will immediately become loosened.

A use for this process, and one which we think can not be too highly appreciated, is the facility it affords for the transport of negatives. For example: it is found desirable to send a dozen negatives from one locality to another, between which the only convenient mode of communication is by post. By means of Mr. Paul's process such transport can be effected with singular ease and certainty. All that is requisite is to transfer the negative to the gelatine paper in the manner described, roll it up, and send it by post to its destination. The recipient of the negative would then carry into effect the subsequent stages of the process, which, we need scarcely say, could be as easily done in London as in Australia or India—the countries in which we may suppose the negatives have been taken.

Again: who does not know to his painful experience the cost and annoyance involving in the storing away of large negatives upon glass—negatives which may never have occasion to be again utilized as such by the owner, and yet with which he would not willingly part? To meet such a case, Mr. Paul's process becomes exceedingly useful. To compare one thing with another, it is similar to the convenience afforded to the typographic printer by the adoption of the French method of stereotyping, by means of which valuable type, or even stereotype plates, need not be kept "standing" or in stock in the expectation of a remote future demand for their services in reprinting any work, seeing that a faithful cast may be taken in plastic material not much thicker than pasteboard, from which at any convenient time a metallic counterpart can be obtained. But Mr. Paul's method of transfer does rather more than this; for, as we have said, the negative may be utilized for printing even while it still remains attached to its paper support, and this without any loss of sharpness.

To conclude: for the condensation or grouping of a number of negatives upon one plate, for the reversing of a negative, for its utilization in either a direct or reversed form, both upon paper and upon glass, and, lastly, for facility of transport of negatives as well as for their storage, the process now described possesses features of incalculable value.—*British Journal of Photography*.

ON THE PREPARATION OF DEXTRINE-MALTOSE (MALT SUGAR) AND ITS USE IN BREWING.

By WM. GEO. VALENTINE, F.C.S.

Royal College of Chemistry, South Kensington.

[A paper read before the Chemical Section of the Society of Arts, London, March 17th, 1876, Prof. Williamson, F.R.S., in the Chair.]

(Continued from page 368.)

DISCUSSION.

MR. O'SULLIVAN said he had worked out this subject in conjunction with Mr. Valentin, and the result of their investigations into the composition of dextrine-maltose was such that any chemist who wished to isolate these particular bodies now could do so with the greatest ease and accuracy, and he could satisfy himself as to their character and composition.

MR. FORDRED asked how the maltose contained in this new body (termed dextrine-maltose) could be identified with the corresponding maltose found in real malt.

MR. O'SULLIVAN replied that its identity was shown by its similar behavior under the polariscope, and by its reducing only two thirds of the quantity of copper oxide which glucose reduces. If cane-sugar were split up into lævulose and dextrose, there was an increase of solid matter of 5.26 per cent; but if starch were split up under this process into maltose and dextrose, there was a theoretical increase of 3.7 per cent. If these substances were submitted to the action of alcohol, and the alcoholic extract evaporated nearly to dryness, about 95 per cent of the maltose was dissolved; it was impossible to dissolve the whole of the maltose at the first operation, but the alcohol solution contained nothing but maltose. If the solution were evaporated to dryness, and again taken up—in order to eliminate any slight trace of dextrine—with stronger alcohol and to the saturated solution a small quantity of ether were added, it would be found that the sugar crystallized out.

MR. FORDRED said he wanted to know how this artificial maltose was identified with the natural maltose obtained from germinated grain.

MR. O'SULLIVAN said that maltose could be crystalized out from maltwort, though it was rather more difficult to isolate it because the malt-wort contained other bodies. It could be done, however, and was found to have precisely the same rotatory power, and the same action on cupric oxide.

MR. REID asked how the nitrogenous matter in the rice was got rid of.

MR. O'SULLIVAN said that when rice was subjected to the action of sulphuric acid, very little of the albuminoids dissolved out; they were much more soluble in alkalies than in acids.

MR. FORDRED asked if this new article (dextrine-maltose) produced by the action of acids on starch, was supposed to represent 50 per cent of dextrine and 50 per cent of glucose.

MR. VALENTIN said no; it represented 67 per cent of maltose and 33 per cent of dextrine.

MR. FORDRED said the exact proportion did not matter; he wished to know if the whole of it could be fermented with yeast.

MR. VALENTIN replied that this point had been mentioned in the paper. He had already stated that maltose was perfectly fermentable, and yielded the same amount of alcohol as cane-sugar, namely, 51 to 52 per cent. All the specific matter was fermentable, except the dextrine. When dextrine and maltose were mixed together in certain definite proportions, the maltose fermented out, and the dextrine was left perfectly unchanged, even at the end of 15 days, whilst the fermentation of the maltose was over in four or five days.

MR. FORDRED said it was difficult to follow a paper containing so many new facts and figures, without having it before one in print. It was well known that an extract of malt, say of 50 gravity, could be reduced, as was done by the distiller, below the specific gravity of water, so that the whole of the solid matter was converted either into alcohol or carbonic acid. It had, however, been ascertained recently with regard to this artificial glucose made from starch, that when yeast was applied, fermentation was set up, but it stopped as soon as the whole of the glucose was decomposed, and the dextrine remained unattacked by the yeast. Now, an infusion of malt could be entirely attenuated down, under certain conditions, and he wished to know, therefore, if a solution of this material had actually been attenuated down below the specific gravity of water.

MR. VALENTIN said Mr. Fordred was under a little misapprehension. The sugar which had to-night been brought under the notice of this meeting consisted of dextrine-maltose, and not of what the speaker was pleased to call glucose, and when handed over to a distiller, would ferment so far only as the maltose was concerned; the dextrine would not ferment. He had been dealing with brewing, not distilling, which was a different process altogether, and the material he had produced represented the natural product of the brewer as he obtained it in mashing. The sugar fermented most readily by yeast, but the dextrine remained unfermented. The attenuation, therefore, could only be carried to the extent that two thirds were converted into alcohol, one third remaining as dextrine for the slight after-fermentation. As he had shown by the analyses, a brewer would as soon think of fermenting the sugar maltose entirely as of throwing his beer away altogether; he must leave in the beer a certain amount of sugar; if he left too much, the beer when put either into cask or bottle would ferment too rapidly; if he left too little, he would leave it to any gentleman present to say what would be the result, the beer would be worthless.

MR. FORDRED wished distinctly to know if the whole of the solid matter of the new material (dextrine maltose) could be converted into alcohol and carbonic acid.

MR. VALENTIN—No. Nor is it desirable for the brewer to do so.

MR. FORDRED said that hitherto the object of the glucose manufacturers had been to convert the whole of their starch into glucose, and to leave as little dextrine as possible in it. They had always endeavored to produce it as rich in sugar as the Inland Revenue standard formerly allowed, which was 80 per cent. Foreign glucose usually contained a large percentage of dextrine (15 to 20 per cent), and was therefore not so valuable to the brewer. Another point was this: he understood Mr. Valentin to say that the proportion of dextrine and glucose in malt infusion was a fixed quantity, but in Dr. Graham's lectures on brewing in that room the whole matter had been, for the first time made plain to any ordinary chemist, and it was shown that the proportion depended on a set temperature and the way in which the mashing was conducted; that in fact it was possible for the brewer to obtain from 100 parts of starch either ⅔ glucose and ⅓ dextrine, or ⅓ glucose and ⅔ dextrine, or any intermediate proportions. It seemed to him, therefore, that it was an error to take any definite constitution of the wort as a starting-point.

MR. O'SULLIVAN wished to explain what was meant by attenuation below the specific gravity of water. Mr. Fordred seemed to think that if this were done, it was a proof that the whole of the solid matter had been converted into alcohol or carbonic acid, but this was not so. The low specific gravity of the alcohol reduced the specific gravity of the whole below that of water very considerably, and the difference would be made up by the solid matter still remaining. If it were all converted into alcohol, the specific gravity would be about .907. The distiller wanted to get as much alcohol as possible out of the starch, but the brewer's object was different; he required a liquid which had been fermented, but was still partially undergoing fermentation, and one which retained a certain amount of "body." If he proceeded in the same way as the distiller, he would obtain a solution altogether fermentable, but beer made in such a way would be very unpalatable. Hitherto even amongst chemists very crude ideas had prevailed as to what dextrine was; it had never been properly isolated and described, but it was upon it, substantially, that the brewer must depend for the body of his beer. It gave the round, full-mouthed flavo. which was generally found in well-brewed beer of the best quality.

MR. BOSDET asked if this dextrine-maltose had been applied to any other manufacturing purposes, as he understood Mr. Valentin to say it might be. It had been stated lately in the *Tanner's Journal* that glucose might be used in various processes connected with tanning, and he should like to know if this new substance could be similarly employed.

MR. VALENTIN said that if the paper had not been already of great length, he should have referred to a few other points, which would, no doubt, have been interesting, though, as yet, the dextrine-maltose had not been applied practically to any other purpose but brewing. He had been told, however, that it would very likely be useful in the evaporation of milk, and for other purposes, especially as it appeared to stand any temperature without change, as shown by the polariscope. As they said in the laboratory, it could be "bullied" to any extent, and this property would probably render it useful in many ways, which he was not yet prepared to specify.

MR. NASH proposed a vote of thanks to Mr Valentin, and took occasion to inveigh against the injustice, as he considered it, of the brewers' license duty.

MR. VALENTIN, in reply to a question, said that the samples of concentrated syrup exhibited had not been in any way decolorized.

DR. GRAHAM said he had some two years ago, when delivering a course of lectures on brewing, called attention to the important researches of Mr. O'Sullivan, with reference to the action of albuminous matters on starch, and showed that his own work corroborated his results. It was not, indeed, until the publication of Mr. O'Sullivan's work that they knew any thing about the constitution of starch, and the way in which it was modified in subsequent processes of brewing. Reference had been made to a statement of his, in the course of those lectures, that within certain limits the brewer could make a more dextrinous, or a more sugary, wort, but of course he did not wish it to be understood that in any case the whole of the starchy matter, when converted into sugar, would disappear in the process of fermentation, and be converted into carbonic acid and alcohol. On the contrary, a portion would remain, which he spoke of as dextrine. The analyses now given of pale ales and malt, and the other details which had been brought forward, were very important, and he had no doubt that this patent process, if the details were properly attended to, would be of great value to the brewer. He would not at all enter into the question whether there was any thing distinctly original in the process, or how far it differed from that employed by French chemists and others.

MR. THORPE said the use of the various saccharine matters hitherto employed by brewers had this effect, that the beer produced was deficient in body, and most persons could tell by the taste whether or not such materials had been used. In the case of this new substance, however, it appeared that a certain amount of dextrine was introduced, as well as the readily fermentable material present in other saccharine bodies. This appeared to be a distinct advantage, and would lessen the danger of having the beers deficient in body. But there was another point, namely, the flavor. That was probably due to some little known bodies present in malt, and you might obtain a beer containing a sufficient quantity of sugar, alcohol, and all the well-known substances, and yet, from deficiency in these nitrogenous flavorings, it would not be so pleasant as ordinary high-class beer. It, therefore, appeared doubtful whether it would ever be possible to use these artificial aids to any great extent for first-class beer. If, however, they were only used in moderation with sufficient malt to furnish the flavor, very good results might be produced.

MR. VALENTIN said the process could be regulated with the greatest nicety, and could reduce the angle shown in the polariscope from 213° down to 171°. If the process were carried farther, the maltose underwent another change, and became converted into glucose; which had quite a different angle. He might point out to any practical brewer that he had in this way four or five hours of slow fermentation before him, and he gained so much time for his fermentation. He might say in reference to the question raised by Mr. Thorpe, that the odor given off in the evaporation was very pure and sweet, and the brewer might draw, so to speak, upon this additional time for producing his flavor, and that beer made from this sugar must yield more of the flavoring matter produced from the fermentation and chemical changes which the sugar underwent on the way to the formation of alcohol. The flavor of wine was due to these changes, though whether the presence of albuminoid matter was connected with it, he would not then discuss.

The vote of thanks having been passed,

THE CHAIRMAN said it was peculiarly the province of science to examine with accuracy what the process was which took place in these wonderful changes of form and structure, as, for instance, in the fermentation of the juice of fruits, or of malt infusion, and then to isolate those conditions which were found favorable to the desired result. It was certainly natural and proper in wine-making for the chemist to add sugar of various kinds when the juice yielded was too acid, and also to add to the expressed skins and seeds of the grape, which were capable of imparting a fresh fermentation and a certain flavor, other sugars, and it was found that the product was as useful for the same purpose as the original grape-juice. In the case of beer, it was sure to be useful to endeavor to arrest the process of change which went on during fermentation at that particular point which had been found by examination to be most advantageous. He should like to ask, therefore, if that process could be relied on for constancy and regularity, so that a constant proportion of dextrine could be depended upon

MR. VALENTIN said the change was so remarkably equal and steady that a difference of five or ten minutes in the length of the process could be traced with the greatest ease by means of the polariscope. When the angle of +171° was passed, the maltose underwent a change towards glucose. The change through which it passed would probably be marked by another sugar of an intermediate polariscopic angle. In many experiments he had succeeded very well without taking a polariscopic reading at all, simply by observing the time of digestion. There was no difficulty in obtaining any quantity of precisely the same character.

THE CHAIRMAN said there could be no doubt that this process would prove very useful in the hands of practical men, and of course its value would greatly depend, amongst other things, on the certainty with which it could be obtained of any particular composition. It seemed to be within the power of the operator to modify it, and if, as he now understood, it was practically possible without an undue amount of skilled labor to stop it at any desired point, it would add greatly to the value of the process.

A vote of thanks to the Chairman for presiding, which was carried unanimously, brought the proceedings to a close.

PHOTOGRAPHS OF BLOOD.

AT a recent meeting of the Massachusetts Institute of Technology, Dr. Cutter exhibited micro-photographs of the blood of man and of some of the higher animals, taken by himself.

His object was to a certain what ground, if any, medico-legal experts had for saying that they could distinguish the blood of a child from that of an adult, or that of man from any other mammal. He had such photographs taken by the aid of a microscope, transferred to glass positives, and then thrown on a screen with the calcium light. The images can thus be measured either directly or by the eye, and any observer, not a microscopist, can determine for himself whether such discrimination is possible, as size is the only morphological element of the red blood corpuscle taken into account by such experts.

He exhibited the blood of man, rat, dog, pig, ox, deer, squirrel, sheep, horse, mouse, cat, rabbit, frog and trout—all taken with the same 1-50 objective, at a distance of twenty-six inches, and reduced upon the glass positives at the same distance from the camera.

The averages of the measurements were as follows:

Man	1-3100 to 1-3200	of an inch.
Dog	1-3200	" "
Squirrel	1-3600	" "
Rat and Rabbit	1-3400	" "
Deer	1-3500	" "
Ox	1-3300	" "
Pig	1-4028	" "
Horse	1-4200	" "
Sheep	1-5600	" "

Other observers differ from the above measurements of Dr. Harriman, but always in a slight degree; and Dr. Woodward could not find any difference between those of man and the dog. Whether such small differences could be of any value in legal medicine he left for his audience to determine, showing, as he did, that in the same specimen the size varies considerably, and that, familiar as he was with the appearances, he could not at a glance distinguish them. He also exhibited the appearance presented by diseased blood, in the various stages of consumption, showing very interesting and characteristic changes in the outlines, appearance and contents of the globules.

Mr. S. Dana Hayes complimented Dr. Cutter on the successful results he had obtained in this difficult line of investigation. He exhibited some photographs by Dr. Wormley, in which two bloods, that of man and that of the dog, were shown, each occupying one half of the field—an admirable way of exhibiting the contrast, and remarkable for the evenness of the distribution, the distinctness of form and outline, and the comparatively low power with which they were taken. He described the probable way in which those were prepared, and stated that there was no reason why four bloods could not thus be exhibited at the same time, a comparison which might have its value in legal medicine.

THE SLEEP OF PLANTS.

AT a recent meeting of the Philadelphia Academy of Sciences, Mr. Thomas Meehan said that what was popularly known as the "sleep of plants," the closing of some kinds at nightfall, though a matter within common observation, had not, so far as he was aware, been made a subject of physiological investigation, with the view of ascertaining the value, if any, of this kind of motion in the economy of plant life. He had recently discovered, by means of this peculiar motion, that the common *claytonia virginica* and some buttercups were fertilized by their own pollen. The fertilization of these plants had been somewhat of a mystery to him, as, in view of some prevailing theories of cross fertilization by insect agency, these plants ought not to be self-fertilized; but from repeated observations he was satisfied that no insects had visited plants that had not yet seeded abundantly. The process of fertilization in claytonia and ranunculus, independent of insect agency, was minutely described.

Plants, of course, have peculiar functions to perform, and there were preordained plans and special arrangements through which these functions are exercised. But the workings of plant life are so complicated that, though we see certain results follow certain movements, we are not always sure that we perceive the great and deeper object arrived at in the order of nature. Hence arose the differences of opinion prevailing in regard to the object of cross fertilization. Some plants had arrangements which seemed to preclude the possibility of self-fertilization, and the assumption followed that nature abhorred close breeding in plants, and specially designed such structures to secure the plant against it. He believed that nature had a deeper purpose, as yet unknown, and chiefly because of such instances as he had given this evening, where nature could not abhor close breeding, when the result of the "sleep of plants" was most perfect in securing self-fertilization.

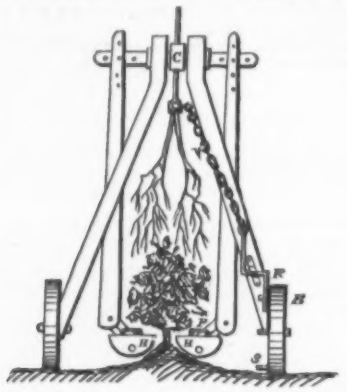
SOLUBILITY OF SALICYLIC ACID.

AT the Paris Therapeutical Society, M. Chassan stated that he has found the addition of citrate of ammonia to greatly increase the solubility of this acid, either in alcohol or in water. Thus, while 40 or 50 parts of rum are required to dissolve 2 of the acid, if 1 part of the citrate of ammonia be added, only 8 parts of rum are required to dissolve the two parts. If from 2½ to 3 parts of the citrate be added, 120 parts of water will dissolve 2 parts of the acid; while without this addition 1000 parts of water would have been required. M. Chassan proposes the following formula: Salicylic acid, 4; citrate of ammonia, 2; rum, 30; and distilled water 164 parts. Or this: Salicylic acid, 1; citrate of ammonia, 2; syrup, 30; and distilled water, 120 parts.

MACHINE FOR DESTROYING POTATO-BEETLES.

A. ISKE, Lancaster, Pa.

THE vertical swinging arms G support the trays or traps H, into which the insects fall, and are precipitated into the trays by the motion of the machine. The central beam C, one side connected with the lever T, is actuated by the pins S on the wheel B. This beam is provided with one or two series of whisks of broom-corn, which beat the

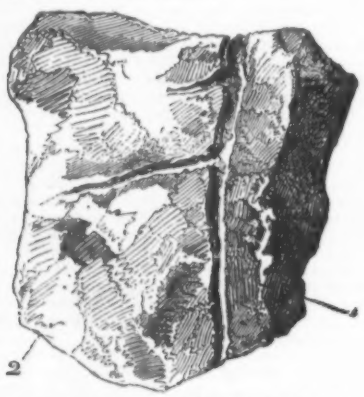


tops and sides of the vines, as the machine is pushed or drawn along straddling the rows, and effectually dislodges all insects, and causes them to fall into the trays or traps H.

The trays are light, and slide along, one on each side of the row of plants, close to their base, while the whisks of broom-corn gently beat the bushes, sweeping or knocking off the beetles, whether the *Doryphora decemliniata*—the well-known Colorado potato-bug—or any other bug or larvæ, so as to lodge them snugly within the trays.

PERFORATION OF A PAVING-BLOCK BY TREE-ROOTS.

WE recently published in the SCIENTIFIC AMERICAN an engraving showing the curious channelling or grooving of a block of marble, above which the fine rootlets of a tree had spread themselves. The corrosion was due to the production of carbonic acid, which determined the solution of the marble in the water by which the soil was impregnated, and its transformation into bicarbonate of lime.



An even more curious instance is illustrated in the annexed engraving, extracted from *La Nature*. The stone is a quartziferous sandstone, with which is combined a calcareous cement, and it is upon the latter that the carbonic acid evolved by the roots has acted to produce remarkable perforations. The roots came from an elm tree, and some as large as one centimetre, others not above one millimetre in diameter, have penetrated the rock. The fibres had long been dead when the specimen was discovered, and their decomposed fragments were found in the passages they had cut. It seems that the finest rootlets penetrated as freely as the thicker and stouter ones.

The cause of the holes is manifestly owing to the disappearance of the cement through its solution, as already stated, and the self-insulation of the roots between the quartz grains. In each case a complete mould of the root was produced, and this appears more clearly visible through the oxide of iron carried in by water giving the interior an ochre hue.

The phenomenon is an exceedingly suggestive one to geologists. The trees of all geological periods have had in their roots the same perforating power, and thus a stratum immensely older than the tree may exhibit apparently very old traces of the latter's roots. A stratum of cretaceous sandstone may, for example, contain tertiary roots, so that to determine the true age of fossils contained in the stratum would seem to be difficult in view of the apparent contradiction of periods evidenced by the presence of the vegetable traces.

ARABLE EARTH.

M. STANISLAS MEUNIER, a well known French chemist, has recently published a work entitled "Arable Earth, of what it is made, how it is formed, and how it is improved." From this *La Nature* takes the annexed engravings and the following abstract:

It is evident that arable earth is produced at all geological epochs, in order to be constantly destroyed and reformed so as always to constitute the superficial covering of the globe. Vestiges of it are found in ancient sedimentary deposits, where it is the residue of the soil, in which the vegetable remains buried therein once developed. In Portland Island, below the strata similarly named, a formation of marine origin is encountered, consisting of a lacustrian limestone 64 feet thick, which supports a dirt bed varying in thickness from 12 to 18 inches. The dirt bed is blackish brown in color, and contains earthy lignites, round stones reaching 9 inches in diameter, and silicified trunks of *coniferæ* and *cicadæ*. Some of these trunks are imbedded in the dirt bed, and their fragments joined together indicate trees of about 23 feet in height. The roots are still fixed to the rock which they formerly penetrated. Examples of this kind could easily be multiplied, did space permit; but fossil vegetable earth in the present essay must give place to that cultivated to-day, which is the subject for our consideration.

In general terms arable earth consists in the mixture of humus with quartziferous sand, limestone, and clay, and it is on the relative proportions o these four fundamental elements that the properties of different earths depend. From this it is evident that chemical analysis can tell us much concerning soils—and processes of this description are numerous; but, on the other hand, the simplest tests often give the most satisfac-

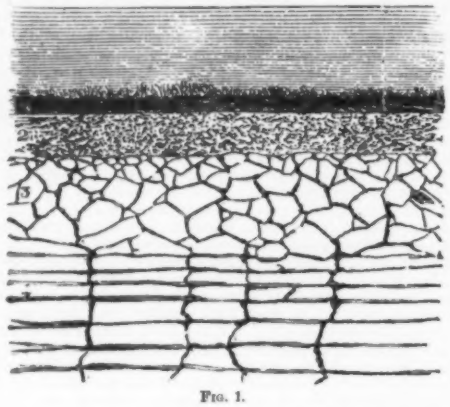


FIG. 1.

tory results. "A simple washing," says M. Boussingault, "certainly tells more than any chemical analysis," and those who have most closely studied the subject adhere to a like opinion.

There can be distinguished, as regards manner of formation, two great classes of arable earth. The one is of local formation, the other results from transportation. Fig. 1 is a reproduction of the condition of the upper portion of a very large number of quarries. Here the arable earth (1) forms the superficial layer, and between it and the virgin rock (4) are found two layers, more or less clearly defined, which represent unequally advanced stages in the transformation of the rock. The upper one (2) is generally designated as the subsoil, and consists in a kind of vegetable earth in which organic matter is sparse, and in which, on the other hand, stones abound, increasing in size with their distance under ground. The other (3) is, so to speak, formed of the reunion of these stones, which becoming progressively aggregated into more and more voluminous masses, finally pass into the form of the continuous rock below. It is obvious from this that local arable earth results primarily from the reduction of the hard rock into fragments, which become mixed with the organic matters produced by the decomposition of plants. The final re-

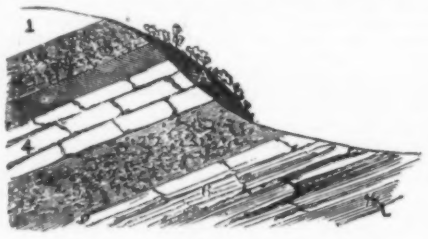


FIG. 2.

sult of the disaggregation of rocks and the decomposition of the minerals which enter into their composition, is the existence of streams flowing from all quarters, forming alluvial deposits, extended like mantles along the slopes of mountains, and on the bottoms of the largest plains and valleys.

If they are formed of sand or clay, these transported deposits may become the base of an arable earth, if they are sufficiently porous and moist, and vegetation soon flourishes in them. Plants first exist which are of a nature that live principally at the expense of the atmosphere, and which require from the earth little more than a point of support. Of this type are the cacti, the grassy plants found in sands, and mimosas. These in their turn leave vegetable remains, useful for succeeding generations, and thus organic matter constantly accumulates, rendering the soil less and less sterile.

The loess, a yellow loam with calcareous secretions, is the type *par excellence* of these transported soils. Its formation dates from the glacial epoch, and it is found in thin layers on all formations. Fig. 2 gives an instance in which the oess A appears on strata of limestone and plastic clay (4 and 5), and extends even up to the Fontainebleau sand (2).

The problem of improving arable earth may be regarded from two points of view. First, there is to determine how an imperfect soil can be brought back to normal condition; and second, what are the substances which, introduced into normal earth, augment its qualities?

The first consideration comprises irrigation, drainage, etc.; the second relates to mineral fertilizers. The last are very numerous, and include plaster, phosphate of lime, nitrate of soda, saltpetre, salt, wood ashes, carnallite, sewage, manure, etc., etc. The most energetic and most sought after are guano and carnallite.

Guano is a true fossilized manure. It is found principally in the Chincha Islands, near Peru, and Fig. 3 represents one of the principal deposits. It contains phosphate of lime, and also ammoniacal salts of great fertilizing power. The production of this valuable material is constant, and the birds of which it is the dejection may be seen in vast throngs in the vicinity of the islands. It forms itself in layers like geological strata, in the midst of which fossil remains of the birds are found, the latter having evidently died from over-gorging, as their finny prey, also fossilized, is found beside them. The climate of the country aids the formation. Rain in that locality is unknown, and none of the guano becomes washed away.

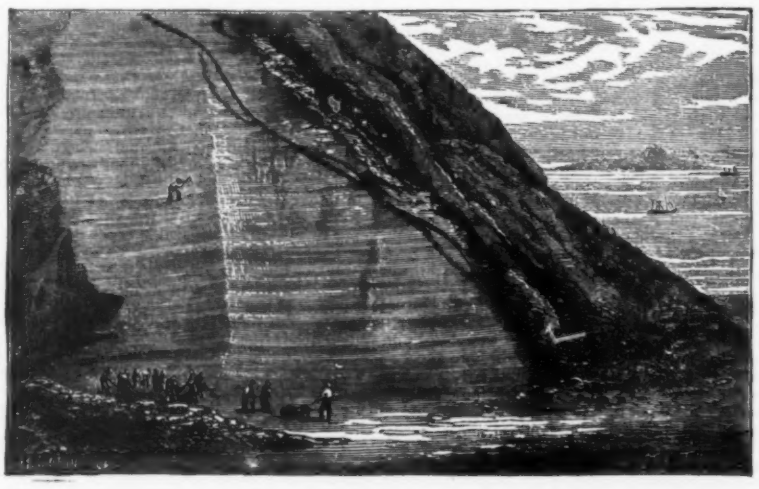


FIG. 3.

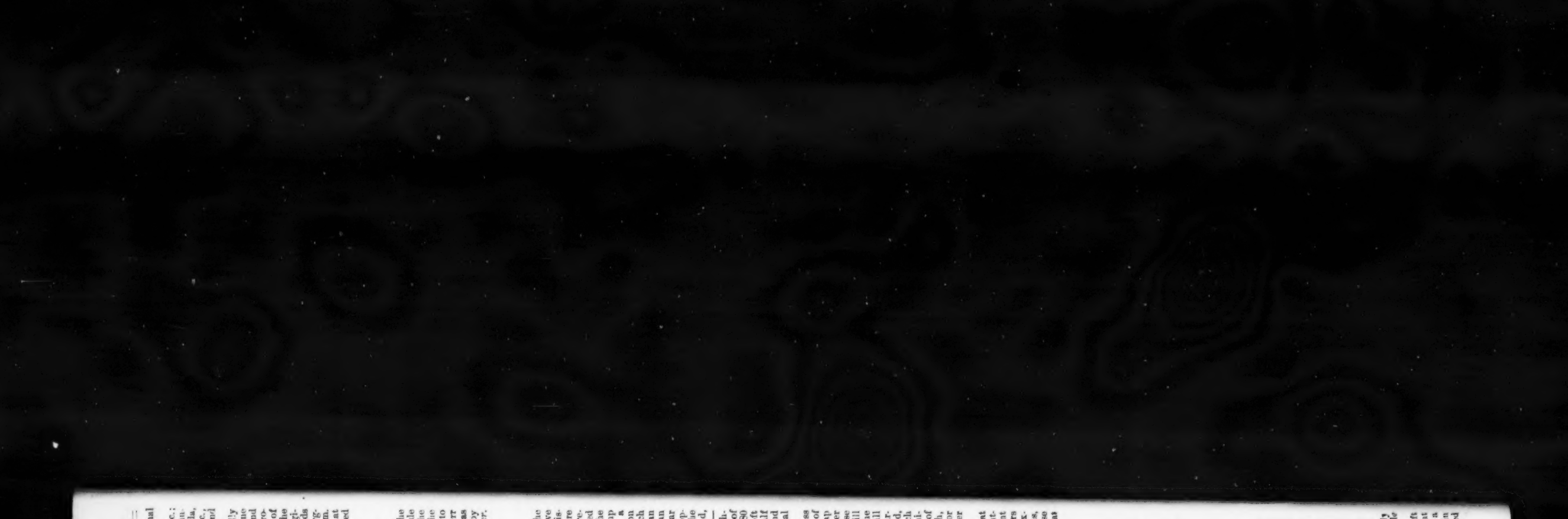
A GROTTO OF HEALTH.

AT Monsummano, in the province of Lucca, high up in the picturesque Apennines, there is a cavern famed far and wide for its beneficent effects on chronic rheumatic sufferers. The invalid breathes the temperate air of the cave, bathes in the medicated waters that drip from its walls, and bids farewell to his sufferings. Such, at least, was the experience of Herr Hugo Knoblauch, a respectable German traveller, who has written a book on the grotto and its effects, well spoken of by our Prussian contemporaries.—*Medical and Surgical Reporter.*

SOFT WOOD FOR TIMBER AND FUEL.

A CANADIAN writer says:—We have just completed the measurement of some American poplar wood, planted to prove the possibility of renewing a fuel supply in Canada, in districts where the original forests have disappeared, and where coal is, from local causes, excessively high in price. The result shows most conclusively that no Canadian farmer need be without a future supply of fuel. I must premise that the soil on which the experiment was tried was a poor, damp sand, and that, great as the result hereafter appears from a row of fir trees, planted 11 years since, I have no hesitation in asserting that, under favorable circumstances of damp, rich soil and good protection, one-eighth more wood per acre can be averaged. Twelve years since we planted six American cottonwood trees and one silver Abele poplar. Last year they were cut down and made into cord wood—that is, chopped into 4-feet lengths and split up into small logs. The land occupied was—allowing for other growth all around, supposing the experiment formed part of a large plantation—a little over 7 rods. The result in timber, wood, and boughwood for fuel was somewhat over 4 cords of 128 cubic fee of cut and piled cord wood, showing a yield per acre of about 80 cords of wood, superior to fine for fuel purposes; and if soft wood building timber had been required, nearly one-half could have been utilized for that purpose as boards and scantlings. The quality of the wood as timber, is about equal to English lime tree or Canadian basswood.

It will not resist decay for any great length of time, unless kept dry and not exposed to the weather, but as the growth of timber trees that will do this is for future generations to "reap where the present have sown," we may well consider whether this soft wood be not much better than none. The expense of raising 1000 of saplings is merely nominal, as they will grow very close together, and only require as manure the enormous mass of leaves these trees, if ever so young, will produce. So, also, is it with the old growing tree; they furnish such a mass of nitrogenous humus, as not only to afford, by the addition of moisture, a heavy deposit of leaves each year, but also so much more than the tree can again assimilate that any land is enormously enriched by the growth of this timber, more especially as it yields but little mineral ash, and may fairly be said not to draw heavily on the soil for those minerals that future and subsequent crops of another sort may require.

The result of the American "poplar Abele," exceeded that of the cottonwood, there being, however, only one tree planted; this may not, therefore, be considered a fair experiment of this variety. There were, however, four Abele poplars planted at the same time by a neighbor, and these far exceeded in yield of trunk timber, and huge limbs or boughs, those we planted. So rapid and gross is the growth of these Abele's, that although they were at one time used in great numbers as shade trees in cities, they are now universally condemned for that purpose, as being utterly unmanageable in their rank, rampant growth.

The Lombardy poplar also yields a large quantity of soft timber and fuel wood, and has the very great advantage, that if headed down at the right season, and even trimmed to a stump, it will spread out so luxuriantly as to furnish again in a few years an enormous yield of bough wood well adapted for fuel and kindling purposes.